Texas Water Development Board
P.O. Box 13231, Austin, Texas 78711-3231

APPLICATION FOR FINANCIAL ASSISTANCE

FOR WATER AND WASTEWATER INFRASTRUCTURE PROJECTS

NOTICE TO ALL APPLICANTS

This application is comprehensive, covering all loan and grant assistance applications for water and wastewater infrastructure financing through the various Texas Water Development Board (TWDB) programs. The format of the application is intended to expedite the review process for both the applicant and TWDB staff. This application is intended for political subdivisions, including Water Supply Corporations.

Each applicant must submit **ONE** double-sided **ORIGINAL** and **ONE** indexed, electronic copy, via electronic storage media such as CD or flash drive using MS Word, Excel and/or Adobe Acrobat. The application must be submitted to**:**

Texas Water Development Board
Water Supply and Infrastructure-Regional Water Planning and Development
P O Box 13231
1700 N. Congress Avenue, 5th Floor
Austin, Texas 78711-3231
(78701 for courier deliveries)

Only **COMPLETE APPLICATIONS** for projects will be considered for funding. A **COMPLETE APPLICATION** consists of all of the applicable information and forms requested in this document.

IMPORTANT NOTICE

Applicants **MUST** use this form for application to ensure all requested information is included for review.

When preparing this application please review the Application and all Guidance and Forms, listed at the end.

TWDB Use Only

Name of Applicant: _____

Date application received: _____

Date administratively complete: _____

Please label each attachment with the number of the pertinent application section (i.e. "Part D5")

Contents

Please label each attachment with the number of the pertinent application section (i.e. "Part D5")

Part A: General Information

1. The legal authority under which the applicant was created and operates.
   - a) ☐ TYPE A GENERAL-LAW MUNICIPALITY (Texas Local Gov't Code Sec. 5.001)
   - b) ☐ TYPE B GENERAL-LAW MUNICIPALITY (Texas Local Gov't Code Sec. 5.002)
   - c) ☐ TYPE C GENERAL-LAW MUNICIPALITY (Texas Local Gov't Code Sec. 5.003)
   - d) ☐ HOME-RULE MUNICIPALITY (Texas Local Gov't Code Sec. 5.004)
   - e) ☐ SPECIAL-LAW MUNICIPALITY (Texas Local Gov't Code Sec. 5.005)
   - f) ☐ NONPROFIT ORGANIZATION (Business Organization Code Chapter 22)
   - g) ☐ NONPROFIT WATER SUPPLY OR SEWER SERVICE CORP. (Texas Water Code Chapter 67)
   - h) X☐ ALL DISTRICTS (Texas Water Code Chapter 49)
   - i) ☐ OTHER (attach)

2. Applicant Name and Contact Information:

Name:	Tarrant Regional Water District
County:	Tarrant
Physical Address:	800 E. Northside Dr. Fort Worth TX 76102
Mailing Address:	800 E. Northside Dr. Fort Worth TX 76102
Phone:	817-335-2491
Fax:	817-877-5137
Website:	Trwd.com

2. Brief description of the project.
TRWD and DWU have partnered to finance, plan, design construct and operate the Integrated Pipeline (IPL) Project. The IPL Project is an integrated water delivery transmission system connecting Lake Palestine to Lake Benbrook with connections to Cedar Creek and Richland-Chambers Reservoirs integrating TRWD's existing pipelines and creating flexibility in delivery as well as quick response to fluctuating customer water demands. The IPL Project consists of 150 miles of pipeline, three new lake pump stations, and three new booster pump stations delivering a required capacity of 350 million gallons per day (MGD) of raw water to North Central Texas. TRWD and DWU currently serve over 4.1 million residents and the IPL will allow these agencies to continue supporting regional community and economic growth. The funding in this bond issue would pay for multiple sections of the pipeline, a lake pump station, a booster pump station, high voltage power, communications transmission infrastructure, project related soft costs, issuance costs and a reserve fund.

4. Applicant's Officers and Members:

Name	**Office Held**
Victor Henderson	Board President
Jack Stevens	Board Vice President
Martha Leonard	Board Secretary
James Lane	Board Secretary Pro-Tem
Mary Kelleher	Board Director
Jim Oliver	General Manager
Alan Thomas	Deputy General Manager

Please label each attachment with the number of the pertinent application section (i.e. "Part D5")

Dan Buhman	Assistant General Manager
Sandy Newby	Director of Finance

5. Applicant's **primary contact person** for day-to-day project implementation.

Name:	Sandy Newby
Title:	Director of Finance
Address:	800 E. Northside Dr., Fort Worth TX 76102
Phone:	817-720-4364
Fax:	817-877-5137
Email:	Sandy.newby@trwd.com

6. Applicant's Consultants (Attach copies of all draft and/or executed contracts for consultant services to be used by the Applicant in applying for financial assistance or constructing the proposed project.):

a) Applicant Engineer N/A x ☐

Firm Name:	
Contact:	
Address:	
Phone:	
Fax:	
Email:	

b) Bond Counsel N/A ☐

Firm Name:	McCall Parkhurst & Horton
Contact:	Alan Raynor
Address:	717 North Harwood, Suite 900, Dallas TX 75201-6587
Phone:	214-754-9200
Fax:	214-754-8250
Email:	araynor@mphlegal.com

c) Financial Advisor N/A ☐

Firm Name:	First Southwest
Contact:	Laura Alexander
Address:	777 Main Street Suite 1200
Phone:	817-332-9710
Fax:	
Email:	Laura.alexander@firstsw.com

Please label each attachment with the number of the pertinent application section (i.e. "Part D5")

d) Certified Public Accountant (or other appropriate rep) N/A x ☐

Firm Name:	
Contact:	
Address:	
Phone:	
Fax:	
Email:	

e) Legal Counsel (if other than Bond Counsel) N/A ☐

Firm Name:	
Contact:	
Address:	
Phone:	
Fax:	
Email:	

f) Any other consultant representing the Applicant before the Board N/A ☐

Firm Name:	
Contact:	
Address:	
Phone:	
Fax:	
Email:	

7. List the counties within the Applicant's service area.

Jack, Wise, Parker, Tarrant, Johnson, Ellis, Navarro, Henderson, Kaufman, Freestone, Denton, Dallas, Collin, Ellis, Rockwall

8. Identify the Applicant's total service area population:

4.1 million - TRWD and DWU combined

9. Applicant is requesting funding from which programs? Check all that apply.

		PROGRAM	AMOUNT REQUESTED
a)	☐	Drinking Water State Revolving Fund (DWSRF)	$ _____
b)	☐	Clean Water State Revolving Fund (CWSRF)	$ _____
c)	☐	Texas Water Development Fund (DFund)	$ _____
d)	☐	State Participation	$ _____
e)	☐	Rural Water Assistance Fund (RWAF)	$ _____
f)	☐ X	State Water Implementation Fund for Texas (SWIFT)	$ 440,000,000
g)	☐	Economically Distressed Areas Program (EDAP)	$ _____
h)	☐	If other please explain: _____	$ _____

Please label each attachment with the number of the pertinent application section (i.e. "Part D5")

10. Other Funding Sources: Provide a list of any other funding source(s) being utilized to complete the project, including Applicant's local contribution, if any, or commitments applied for and/or received from any other funding agency for this project or any aspect of this project. **Provide commitment letters if available. Additional funding sources must be included within the Project Budget (TWDB-1201).**

Funding Source	Type of Funds (Loan/Grant)	Amount ($)	Date Applied for Funding	Anticipated or Funding Secured Date
TRWD	Contract Revenue Bonds	194,700,000	January 2018	March 2018
TRWD (City of Dallas Project)	Water Transmission Facilities Contract Revenue Bonds	67,000,000	January 2018	March 2018
Total Funding from All Sources		$261,700,000		

Comments: The 2018 bond issues will complete the joint sections and continue property purchases on the remaining sections.

11. Applicant is requesting funding for which phase(s)? Check all that apply.

- ☐ Planning
- X☐ Acquisition
- X☐ Design
- X☐ Construction

12. Is Applicant requesting funding to refinance existing debt?

- ☐ Yes If yes, attach a copy of the document securing the debt to be refinanced.
  - ☐ **Attached document**
- X☐ No

Please label each attachment with the number of the pertinent application section (i.e. "Part D5")

Part B: Legal Information

13. Cite the legal authority under which the Applicant can issue the proposed debt including the authority to make a proposed pledge of revenues.

Chapter 268, Acts of the 55th Legislature of the State of Texas, Regular Session, 1957, as amended.

14. What type of pledge will be used to repay the proposed debt?
- ☐ Systems Revenue
- ☐ Taxes
- ☐ Combination of systems revenues and taxes
- x☐ Other (Contract Revenue, etc.)

15. Provide the full legal name of the security for the proposed debt issue(s).

Tarrant Regional Water District, A Water Control and Improvement District, Water Revenue Bonds, Series 2015

And

Tarrant Regional Water District, A Water Control and Improvement District, Water Transmission Facilities Contract Revenue Bonds (City of Dallas Project), Series 2015

16. Describe the pledge being offered and any existing rate covenants.

"Pledged Revenues," which specifically include certain amounts to be received by the Applicant (i) pursuant to the "Tarrant County Regional Water Supply Facilities Contract," dated as of August 29,1979, among the Applicant and the Cities of Fort Worth and Mansfield, Texas , the "Tarrant County Regional Water Supply Facilities Supplemental Contract For Trinity River Authority of Texas", dated as of March 12, 1979, between and the Applicant and the Trinity River Authority of Texas, and the "Tarrant County Regional Water Supply Facilities Amendatory Contract," dated September 1, 1982, among the Applicant, the Cities of Fort Worth, Arlington, and Mansfield, Texas and Trinity River Authority of Texas, and (ii) pursuant to contracts with other water customers of the Applicant.

And

Contract revenue payment, designated as "Dallas Bond Payments" made by the City of Dallas, Texas pursuant to a "Water Transmission Facilities Financing Agreement," dated November 16, 2010, between the Applicant and the City of Dallas, Texas

17. Attach the resolution from the governing body requesting financial assistance.
TWDB-0201A (http://www.twdb.texas.gov/financial/instructions/)
- x☐ **Attached Resolution**

18. Attach the Application Affidavit
TWDB-0201 (http://www.twdb.texas.gov/financial/instructions/)
- x☐ **Attached Applicant Affidavit**

Please label each attachment with the number of the pertinent application section (i.e. "Part D5")

19. Attach the Certificate of Secretary
TWDB-201B (http://www.twdb.texas.gov/financial/instructions/)
x☐ **Attached Certificate of Secretary**

20. Is the applicant a Water Supply Corporation (WSC)?
☐ Yes If yes, attach each of the following:
☐ **Articles of Incorporation**
☐ **Certificate of Incorporation from the Texas Secretary of State evidencing that the current Articles of Incorporation are on file with the Secretary**
☐ **By-laws and any amendments**
☐ **Certificate of Status from the Texas Secretary of State (i.e. Certificate of Existence)**
☐ **Certificate of Account Status from the Texas Comptroller of Public Accounts (certifies that the WSC is exempt from the franchise tax and that the WSC is in good standing)**.
X☐ No

21. Is the applicant proposing to issue revenue bonds?
X☐ Yes If yes, attach copies of the most recent resolution/ordinance(s) authorizing any outstanding parity debt. This is essential to insure outstanding bond covenants are consistent with covenants that might be required for TWDB financing.
X☐ **Attached resolution/ordinance(s)**

☐ No

22. Does the applicant possess a Certificate of Convenience and Necessity (CCN)?
☐ Yes If yes, attach a copy of the CCN and service area map showing the areas the applicant is allowed to provide water or wastewater services.
☐ **Attached CCN and service area map**
X☐ No If no, indicate the status of the CCN. _____
☐ N/A

23. Has the applicant been the subject of any enforcement action by the Texas Commission on Environmental Quality (TCEQ), the Environmental Protection Agency (EPA), or any other entity within the past three years?
☐ Yes If yes, attach a brief description of every enforcement action within the past three years and action(s) to address requirements.
☐ **Attached**
X☐ No

Please label each attachment with the number of the pertinent application section (i.e. "Part D5")

24. Are any facilities to be constructed or the area to be served within the service are of a municipality or other public utility?

☐ Yes If yes, has the applicant obtained an affidavit stating that the utility does not object to the construction and operation of the services and facilities in its service area?

☐ If yes, attach a copy of the affidavit.

☐ **Attached affidavit**

☐ If no, provide an explanation as to why not. _____

x☐ No

25. If the assistance requested is more than $500,000 a Water Conservation Plan (WCP) is required. The WCP cannot be more than **FIVE** years old and must have been adopted by the applicant. Has the applicant adopted a Board-approved WCP? (Check one and attach requested information, if any.)

X☐ Yes Enter date of Applicant's WCP adoption: May 20,2014

☐ No If no, attach a copy of a draft Water Conservation Plan and Drought Contingency Plan prepared in accordance with the TWDB WCP Checklist (http://www.twdb.state.tx.us/financial/instructions/doc/TWDB-1968.pdf)

☐ **Attached Draft WCP and Drought Contingency Plan**

☐ **Attached Utility Profile TWDB-1965**

http://www.twdb.state.tx.us/financial/instructions/doc/TWDB-1965.pdf

☐ N/A (Request is $500,000 or less per Water Code §§ 15.106(c), 17.125(c), 17.277(c), and 17.857(c))

Note: If the applicant will utilize the project financed by the TWDB to furnish services to another entity that in turn will furnish services to the ultimate consumer, the requirements for the WCP may be met through contractual agreements between the applicant and the other entity providing for establishment of a water conservation plan. The provision requiring a WCP shall be included in the contract at the earliest of: the original execution, renewal or substantial amendment of that contract, or by other appropriate measures.

26. Does the applicant provide retail water services?

☐ Yes If yes, has the applicant already submitted to the TWDB the annual water use survey of groundwater and surface water for the last **THREE** years?

☐ Yes

☐ No If no, please download survey forms and attach a copy of the completed water use surveys to the application.
http://www.twdb.texas.gov/waterplanning/waterusesurvey/index.asp

☐ **Attached Water Use Survey**

X☐ No

Please label each attachment with the number of the pertinent application section (i.e. "Part D5")

27. Is the applicant a retail public utility that provides potable water?

☐ Yes If yes, has the applicant already submitted the most recently required water loss audit to the TWDB?

☐ Yes

☐ No If no, and if applying for a water supply project, please complete the online TWDB Water Audit worksheet found at http://www.twdb.texas.gov/conservation/resources/waterloss-resources.asp and attach a copy to the application.

☐ **Attached TWDB Water Audit worksheet**

X☐ No

28. Does the Applicant provide wastewater services?

☐ Yes

X☐ No

Please label each attachment with the number of the pertinent application section (i.e. "Part D5")

Part C: Financial Information

Regional or wholesale providers, complete questions 29-31. All others skip to question 32.

29. List top **TEN** customers of the system by annual usage in gallons and percentage of total usage, including whether any are in bankruptcy.

Customer Name	Annual Usage (gal)	Percent of Usage	Bankruptcy (Y/N)
City of Fort Worth	65,947,530,000	58%	N
City of Arlington	19,691,215,000	18%	N
Trinity River Authority	11,130,920,000	10%	N
City of Mansfield	3,902,516,000	4%	N
City of Weatherford	2,072,888,000	2%	N
Brazos Electric	1,528,096,000	1%	N
Waxahachie	1,077,830,000	1%	N
Freestone	1,013,700,000	1%	N
Benbrook Water/Sewer	952,966,000	1%	N
Suez Power	861,774,000	1%	N

Comments: _____

30. List the top TEN customers of the system by gross revenues and percent of total revenues, including whether any are in bankruptcy

Customer Name	Annual Revenue($)	Percent of Revenue	Bankruptcy (Y/N)
City of Fort Worth	70,471,709	58%	N
City of Arlington	21,255,303	18%	N
Trinity River Authority	12,034,940	10%	N
City of Mansfield	4,223,525	4%	N
Freestone	2,264,621	2%	N
Brazos Electric	1,572,939	1%	N
Waxahachie	1,222,119	1%	N
Suez Power	925,651	1%	N
City of Weatherford	850,613	1%	N
Walnut Creek SUD	704,827	1%	N

Please label each attachment with the number of the pertinent application section (i.e. "Part D5")

31. Provide a summary of the wholesale contracts with customers

Contract Type	Minimum annual amount	Usage fee per 1,000 gallons	Annual Operations and Maintenance	Annual Capital Costs	Annual Debt Service	Other
City of Fort Worth – Take or pay	Average annual mgd actually taken from system for the preceding 5 consecutive periods	1.07383 for in District and 1.08883 for out of District for 2015	Approximately 60% of total system costs	Approximately 60% of total system costs	Approximately 60% of total system costs	Approximately 60% of total system costs
City of Arlington – Take or pay	Average annual mgd actually taken from system for the preceding 5 consecutive periods	1.08233 for 2015	Approximately 18% of total system costs	Approximately 18% of total system costs	Approximately 18% of total system costs	Approximately 18% of total system costs
Trinity River Authority – Take or pay	Average annual mgd actually taken from system for the preceding 5 consecutive periods	1.08883 for 2015	Approximately 10% of total system costs	Approximately 10% of total system costs	Approximately 10% of total system costs	Approximately 10% of total system costs
City of Mansfield – Take or pay	Average annual mgd actually taken from system for the preceding 5 consecutive periods	1.08883 for 2015	Approximately 4% of total system costs	Approximately 4% of total system costs	Approximately 4% of total system costs	Approximately 4% of total system costs

Please label each attachment with the number of the pertinent application section (i.e. "Part D5")

All applicants complete questions 32-51 of the financial section, as applicable.

32. List top **TEN** customers of the water system by annual revenue with corresponding usage and percentage of total use, including whether any are in bankruptcy.

WATER

Customer Name	Annual Usage (gal)	Percent of Total Water Revenue	Bankruptcy (Y/N)
City of Fort Worth	65,947,530,000	58%	N
City of Arlington	19,691,215	18%	N
Trinity River Authority	11,130,920,000	10%	N
City of Mansfield	3,902,516,000	4%	N
City of Weatherford	2,072,888,000	2%	N
Brazos Electric	1,528,096,000	1%	N
Waxahachie	1,077,830,000	1%	N
Freestone	1,013,700,000	1%	N
Benbrook Water/Sewer	952,966,000	1%	N
Suez Power	861,774,000	1%	N

List top **TEN** customers of the wastewater system by annual revenue with corresponding usage and percentage of total use, including whether any are in bankruptcy.

WASTEWATER

Customer Name	Annual Usage (gal)	Percent of Total Wastewater Revenue	Bankruptcy (Y/N)
na			

Please label each attachment with the number of the pertinent application section (i.e. "Part D5")

33. Current Average Residential Usage and Rate Information

Service	Date of Last Rate Increase	Avg. Monthly Usage (gallons)	Avg. Monthly Bill ($)	Avg. Monthly Increase Per Customer($)	Projected Monthly Increase Necessary ($)
Water	na				
Wastewater	na				

We don't provide residential water

34. Provide the number of customers for each of the past five years.

Year	Number of Customers
2014	41
2013	41
2012	41
2011	41
2010	41

35. Disclose all issues that may affect the project or the applicant's ability to issue and/or repay debt (such as anticipated lawsuits, judgments, bankruptcies, major customer closings, etc.).
none

36. Has the applicant ever defaulted on any debt?
☐ Yes If yes, disclose all circumstances surrounding prior default(s). _____
x☐ No

37. Does the applicant have taxing authority?
☐ Yes
x☐ No, not for water supply

38. Provide the last five-years of data showing total taxable assessed valuation including net ad valorem taxes levied, corresponding tax rate (detailing debt service and general purposes), and tax collection rate.

Fiscal Year Ending	Net Taxable Assessed Value ($)	Tax Rate	General Fund	Interest & Sinking Fund	Tax Levy $	Percentage Current Collections	Percentage Total Collections
20	na						
20							
20							
20							
20							

Comments: _____

Please label each attachment with the number of the pertinent application section (i.e. "Part D5")

39. Attach the last five-years of tax assessed values delineated by Classification (Residential, Commercial and Industrial). **If applicant does not have taxing authority, provide the assessed values of the county.**

a) ☐ **20** **attached**
b) ☐ **20** **attached**
c) ☐ **20** **attached**
d) ☐ **20** **attached**
e) ☐ **20** **attached**

40. Attach the direct and overlapping tax rate table:
☐ **Attached tax rate table**

41. Provide the current top **TEN** taxpayers showing percentage of ownership to total assessed valuation. State if any are in bankruptcy and explain anticipated prospective impacts in the Comments blank, below. If any of these have changed in the past three years, please provide information on the changes to the top ten.

Taxpayer Name	Assessed Value	Percent of Total	Bankruptcy (Y/N)
na			

Comments: _____

42. Provide the maximum tax rate permitted by law per $100 of property value. _____

43. Does the applicant collect sales tax?
☐ Yes Provide the sales tax collection history for the past five years.

Fiscal Year Ending	Total Collections
20	na
20	
20	
20	
20	

x☐ No

Please label each attachment with the number of the pertinent application section (i.e. "Part D5")

44. Indicate the tax status of the proposed loan?
    - x☐ Tax-Exempt
    - ☐ Taxable

45. Proforma **(Select one of the four listed below) Please be sure the proforma reflects the schedule requested, including multi-phased funding options.**
    a. System revenues are anticipated to be used to repay the proposed debt. Attach a proforma indicating the following information for each year the debt is outstanding:
        - ☐ projected gross revenues
        - ☐ operating and maintenance expenditures
        - ☐ outstanding and proposed debt service requirements
        - ☐ net revenues available for debt service and coverage of current and proposed debt paid from revenues

    b. Taxes are anticipated to be used to repay the proposed debt. Attach a pro forma indicating the following information for each year the debt is outstanding:
        - ☐ outstanding and proposed debt service requirements
        - ☐ the tax rate necessary to repay current and proposed debt paid from taxes
        - ☐ list the assumed collection rate and tax base used to prepare the schedule

    c. Combination of system revenues and taxes to be used to repay the proposed debt. Attach a pro forma indicating the following information for each year the debt is outstanding:
        - ☐ projected gross revenues, operating and maintenance expenditures, net revenues available for debt service
        - ☐ outstanding and proposed debt service requirements
        - ☐ the tax rate necessary to pay the current and proposed debt
        - ☐ list the assumed collection rate and tax base used to prepare the schedule

    d. Another type of pledge will be used to repay the proposed debt. Attach a pro forma with information for each year the debt is outstanding, which includes projected revenues, annual expenditures, outstanding debt requirements, and revenues available for debt service.
        - x☐ Attached

46. Attach a **FIVE** year comparative system operating statement (not condensed) including audited prior years and an unaudited year-to-date statement. Unaudited year-to-date statement must reflect the financial status for a period not exceeding the latest six months.
    - x☐ **Attached Operating Statement.**

47. Attach **ONE** copy of an annual audit of financial statements, including the management letter, for the preceding fiscal year prepared by a certified public accountant or firm of accountants and, if the last annual audit was more than 6 months ago, then, provide interim financial information.
    - x☐ **Attached Annual Audit**
    - x☐ **Attached Management Letter**
    - x☐ **If applicable, attached interim financial information**

Please label each attachment with the number of the pertinent application section (i.e. "Part D5")

48. Does the applicant have any outstanding debt? (Check all that apply)
- ☐ Yes, General obligation debt
- x☐ Yes, Revenue debt
- ☐ Yes, Authorized but unissued debt
- ☐ No

49. Attach a listing of total outstanding debt and identify the debt holder. Segregate by type (General Obligation or Revenue) and present a consolidated schedule for each, showing total annual requirements. Note any authorized but unissued debt.

a. General Obligation Debt:
- ☐ Yes
  - ☐ **Attached schedule. The schedule should also identify the debt holder.**
- x☐ No

b. Revenue:
- x☐ Yes
  - ☐ **Attached schedule. The schedule should also identify the debt holder.** Sold on open market so cannot identify debt holders.
- ☐ No

c. Authorized by Unissued Debt:
- ☐ Yes
  - ☐ **Attached schedule. The schedule should also identify the debt holder.**
- x☐ No

50. List the ten largest employers of the Applicant's service area:

Name	Number of Employees
American Airlines	22,170
Texas Health Resources	18,866
Lockheed Martin	15,000
NAS Fort Worth JRB	11,350
Fort Worth ISD	11,000
Arlington ISD	8,100
University of Texas Arlington	6,240
City of Fort Worth	6,200
JPS Health Network	4,900
Cook Children's Health Care System	4,800

Comments (example, any anticipated changes to the tax base, employers etc.) _____

Please label each attachment with the number of the pertinent application section (i.e. "Part D5")

51. Provide any current bond ratings with date received.

	Standard & Poor's	Date Received	Moody's	Date Received	Fitch	Date Received
G.O.	na	na	na	na	na	na
Revenue	AAA	1/22/2015	na	na	AA	1/26/2015

52. Is the project intended to allow the applicant to provide or receive water or sewer services to or from another entity?

☐ Yes. If yes, the applicant must attach, at a minimum, the proposed agreement, contract, or other documentation establishing the service relationship, with the final and binding agreements provided prior to loan closing.

☐ **Attached**

x☐ No. Only raw water, not treated

Please label each attachment with the number of the pertinent application section (i.e. "Part D5")

Part D: Project Information

53. Description of Project Need (for example, is the project needed to address a current compliance issue, avoid potential compliance issues, extend service, expand capacity, etc.):

TRWD and DWU have partnered to finance, plan, design construct and operate the Integrated Pipeline (IPL) Project. The IPL Project is an integrated water delivery transmission system connecting Lake Palestine to Lake Benbrook with connections to Cedar Creek and Richland-Chambers Reservoirs integrating TRWD's existing pipelines and creating flexibility in delivery as well as quick response to fluctuating customer water demands. The IPL Project consists of 150 miles of pipeline, three new lake pump stations, and three new booster pump stations delivering a required capacity of 350 million gallons per day (MGD) of raw water to North Central Texas. TRWD and DWU currently serve over 4.1 million residents and the IPL will allow these agencies to continue supporting regional community and economic growth. The funding in this bond issue would pay for multiple sections of the pipeline, a lake pump station, a booster pump station, high voltage power, communications transmission infrastructure, project related soft costs, issuance costs and a reserve fund.

54. Description of Project, including a bulleted list of project elements/components, and alternatives considered (including existing facilities):

A complete preliminary engineering feasibility report must include:

a. A description and purpose of the project, including existing facilities.
   - Note: CWSRF and DWSRF must address issues scored in Intended Use Plan submittal

   NA ☐ **Attached**

b. **If project is for <u>Construction only</u>, then attach** the appropriate Engineering Feasibility Report:

   a) <u>Water</u> (TWDB-0555 at http://www.twdb.texas.gov/financial/instructions/doc/TWDB-0555.pdf)
   x☐ **Attached**

   b) <u>Wastewater</u> (TWDB-0556 at http://www.twdb.texas.gov/financial/instructions/doc/TWDB-0556.pdf)
   NA ☐ **Attached**

c. DWSRF applicants must complete a Projected Draw Schedule (TWDB-1202 at http://www.twdb.texas.gov/financial/instructions/doc/TWDB-1202.xls)

55. Water Made Available (For projects requesting a construction component):

*a. New supply 392,077.07 (acre-feet/year**)** $2,323,360,000($) capital cost*

- The **increase** in the total annual volume of water supply that will be made available to the recipient(s) by the proposed project.
- Water Plan project examples: new groundwater wells, reservoir development, pipelines to sources.

Please label each attachment with the number of the pertinent application section (i.e. "Part D5")

b. New Conservation savings___na_____(acre-feet/year) _____($) capital cost

- Annual volume of anticipated water savings resulting from implementation of the proposed conservation project including water loss) and other conservation activities,
- Water Plan project examples: municipal conservation, advanced Water Conservation, on-farm conservation, brush control, irrigation conservation.

c. New Reuse supply _____na_____(acre-feet/year) _____($) capital cost

- Increase in the annual volume of (direct or indirect) reuse water supply that will be made available to the recipient(s) by the proposed project.
- Water Plan project examples: direct reuse, non-potable reuse, recycled water programs.

d. Maintenance of Current Supply_____na_____(acre-feet/year) _____($) capital cost

- Volume of recipients' current supplies that will be maintained by implementing the proposed project
- Water Plan project examples: None. Not a water plan project. (Examples of these type projects: treatment rehabilitation, system storage facilities, system upgrades).

56. Project Location:
see map

Attach a map of the service area and drawings as necessary to locate and describe the project. The map should show the project footprint and major project components.
x☐ **Attached**

57. Attach the Census tract numbers in which the applicant's service area is within. The Census tracts within your area may be found at:
http://factfinder2.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t.

Please follow these steps:

- Select Advanced Search.
- Select the Geographies button located below Topics (left side of page).
- On the top of the window select the Name tab.
- In the text box, type "All Census Tracts within___" (Fill in the blank with the name of a County Subdivision or a Place.) Select "Go".
- If your town is a County Subdivision, select the geography labeled "All Census Tracts (or parts) within City, County, State" from the Geography Results. If your town is a place select the geography labeled "All Census Tracts (or parts) full-or-partially within City, State" from the Geography Results.
- Close the Geographies Search window.
- Use the Topics on the left side of the page to further refine your search or to select a table(s) from your search results.

x☐ **Attached Census tracts**

Please label each attachment with the number of the pertinent application section (i.e. "Part D5")

58. Project Schedule:
    a) Requested loan closing date.
       December 2015
    b) Estimated date to submit environmental planning documents.
       May 2015, see #66 404 permit
    c) Estimated date to submit engineering planning documents.
       May 2015, see #54
    d) Estimated date for completion of design.
       Jan 2016 – Section – 12 & 14
       Mar 2016 – Section – 10,11,17,17 and JB4
       Dec 2016 – JCC1 Intake
    e) Estimated Construction start date for first contract.
       January 2016
    f) Estimated Construction end date for last contract.
       November 2020

59. **Attach** a copy of current and future populations and projected water use or wastewater flows. Include entities to be served.
    x☐ **Attached**

60. Attach the most current itemized project cost estimate (include all costs and funding sources). Utilize the budget format provided (TWDB-1201 at http://www.twdb.texas.gov/financial/instructions/ . If applying for pre-construction costs only (i.e., P, A, D) then itemize only the relevant portions in the attached budget template
    X☐ **Attached**

61. Attach the appropriate Project Information Form:
    ☐ **Wastewater:** Attached a completed Wastewater Project Information Form WRD-253a http://www.twdb.texas.gov/financial/instructions/index.asp

    x☐ **Water:** Attached a completed Water Project Information Form WRD-253d http://www.twdb.texas.gov/financial/instructions/index.asp

62. If the project is for Construction only, wastewater projects that involve the construction of a new plant or the expansion of an existing plant and/or associated facilities, attach evidence that an application for a new Texas Pollution Discharge Elimination System Permit or amendment to an existing permit related to the proposed project has been filed with the Texas Commission on Environmental Quality (TCEQ). Final permit authorization must be obtained from the TCEQ before funds can be released for construction activities.
    ☐ **Attached**
    x☐ No. Provide explanation: na, funds are for a pipeline

63. **All Wastewater applicants** must be a Designated Management Agency (DMA) for wastewater collection and treatment. Please complete and attach DMA resolutions. WRD-210 (http://www.twdb.texas.gov/financial/instructions/index.asp) is an example of this type of resolution.
    ☐ **Attached**
    x☐ N/A

Please label each attachment with the number of the pertinent application section (i.e. "Part D5")

64. If this project will result in: (a) an increase by the applicant in the use of groundwater, (b) drilling a new water well, or (c) an increase by the applicant in use of surface water, then the applicant must demonstrate that it has acquired – by contract, ownership or lease – the necessary property rights, groundwater permits, and/or surface water rights sufficient for the project before funds can be released for construction.

a) Does the applicant currently own all the property rights, groundwater permits and surface water rights needed for this project?

☐ Yes If yes, please attach the completed, appropriate form.
1. WRD 208A (http://www.twdb.texas.gov/financial/instructions/index.asp) (Surface Water)
☐ **Attached**
2. WRD 208B (http://www.twdb.texas.gov/financial/instructions/index.asp) (Groundwater)
☐ **Attached**

X☐ No

☐ N/A

b) If all property rights, groundwater permits, and surface water rights, needed for this project have not yet been acquired, identify the rights and/or permits that will need to be acquired and provide the anticipated date by which the applicant expects to have acquired such rights and/or permits.

Type of Permit Water Right	Entity from which the permit or right must be acquired	Acquired by lease or full ownership	Expected acquisition date	Permit / Water Right ID No.
na				

c) List any major permits not identified elsewhere that are necessary for completion of project. Also, list any more necessary minor permits that may involve particular difficulty due to the nature of the proposed project.

Permit	Issuing Entity	Permit Acquired (Y/N)
08-4976	TCEQ	Y
08-5035	TCEQ	Y
08-4976D	TCEQ	Y
08-5035D	TCEQ	Y

65. Has the applicant obtained all necessary land and easements for the project?

☐ Yes. If yes, attach the site certificate (ED-101 at http://www.twdb.texas.gov/financial/instructions/index.asp
☐ **Attached**

x☐ No. If no, **fill out the table below** and describe the land or easements that will need to

Please label each attachment with the number of the pertinent application section (i.e. "Part D5")

be acquired, provide the anticipated date by which the applicant expects to have the land or easements, and indicate if funding from TWDB is to be used for the acquisition.

Description of Land or Easement Permit	Entity from which the permit or right must be acquired	Acquired by lease or full ownership	Expected acquisition date	To Be Funded by TWDB (Yes/No)
Approx 200 easements left to acquire	numerous	easements	12/2019	yes

66. Has a Categorical Exclusion (CE), Determination of No Effect (DNE), Finding of No Significant Impact (FONSI), Record of Decision (ROD), or any other environmental determination been issued for this project?
- x☐ Yes 404 permit
- ☐ Attach a copy of the finding.
- ☐ No

67. Is the project potentially eligible for a Categorical Exclusion (CE)/ Determination of No Effect (DNE) because it involves only minor rehabilitation or the functional replacement of existing equipment?
- ☐ Yes
- x☐ No

68. Are there potentially adverse environmental or social impacts that may require mitigation or extensive regulatory agency or public coordination (e.g. known impacts to properties eligible for listing on the National Register of Historic Places; potentially significant public controversy; need for an individual permit from the U.S. Army Corps of Engineers)?
- x☐ Yes
  - x☐ If yes, attach additional information 404 Permit
- ☐ No

Please label each attachment with the number of the pertinent application section (i.e. "Part D5")

Part E: State Water Implementation Fund for Texas (SWIFT) Applicants Only:

69. Identify the type of SWIFT funding (If more than one funding option is being requested indicate the amount of funding for each):

☐	Deferred	$
x☐	Low Interest Loan	$440,000,000
☐	Board Participation	$

70. For multi-year funding request or phased commitments, provide a schedule reflecting the closing dates for each loan requested.

Na

☐ **Attached**

71. **Notice to SWIFT Applicants**: Texas Water Code Sec. 15.435(h) requires all recipients of financial assistance from the State Water Implementation Fund for Texas (SWIFT) to acknowledge any applicable legal obligations in federal law, related to contracting with disadvantaged business enterprises, and state law, related to contracting with historically underutilized businesses. Checking the box below serves as this acknowledgement.

x☐As an applicant for financial assistance from the State Water for Implementation Fund for Texas (SWIFT), I acknowledge that that this project must with any applicable legal obligations in federal law related to contracting with disadvantaged business enterprises and state law (Texas Government Code Chapter 2161 and Texas Administrative Code Chapter 20, Subchapter B) related to contracting with historically underutilized businesses.

72. Provide drafts of the following documents:

a. Proposed Bond Ordinance

x☐ **Attached**

b. Private Placement Memorandum

x☐ **Attached**

Please label each attachment with the number of the pertinent application section (i.e. "Part D5")

Part F: Economically Distressed Programs (EDAP) Applicants Only:

In accordance with TWDB Rules (31 TAC Chapter 363), an application for EDAP will **not** be considered until the County has adopted and is enforcing the Model Subdivision Rules (MSRs) Texas Water Code § 16.343. If the proposed project is within a municipality or its extraterritorial jurisdiction (ETJ), or if the applicant is a municipality, the municipality must also have adopted and be enforcing MSRs.

73. Describe procedures for collecting monthly customer bills (include procedures for collection of delinquent accounts)

_____

74. Is financing being requested for a **wastewater** project?
    - ☐ Yes If yes, does the applicant have the required resolution/ordinance establishing a mandatory hookup policy?
        - ☐ Yes. If yes, attach a copy of the resolution/ordinance.
            - ☐ **Attached**
        - ☐ No. If no, explain_____
    - ☐ No

75. Required documentation for the project area for Preliminary EDAP Eligibility (31 TAC Chapter 363)
    - ☐ **Attached** documentation of inadequacy of water and/or wastewater services.
    - ☐ **Attached** documentation regarding the financial resources of the residential users in the EDAP area. Census data or documentation regarding median household income should be provided.
    - ☐ **Attached** documentation demonstrating existence of a residence in the project area prior to **June 1, 2005**. This could include tax records of residence, dated aerial maps, or, other documentation demonstrating existence of a residence.

76. Has the Department of State Health Services issued a determination stating a public health nuisance exists in the project area?
    - ☐ Yes If yes, attach a copy of the determination.
        - ☐ **Attached**
    - ☐ No If no determination exists, attach documentation demonstrating a public health nuisance exists in the project area. (*Photographs may be submitted, but they **must** be labeled with location and date when taken. If the soil types are mentioned in the project area as an issue, include soil profile maps) This documentation will be used by TWDB staff to request a determination from the Department of State Health Services*
        - ☐ **Attached**

77. Is this project providing new service?
    - ☐ Yes If yes, attach plats of the affected subdivisions.
        - ☐ **Attached**
    - ☐ No

78. Attach an EDAP Facility Engineering Plan/Scope of Services report that complies with the requirements of WRD-023A. http://www.twdb.texas.gov/financial/instructions/index.asp
    - ☐ **Attached**

Please label each attachment with the number of the pertinent application section (i.e. "Part D5")

Part G: CWSRF/DWSRF Applicants Only

Only applicants applying for funding from the CWSRF and DWSRF Programs must complete this section.

Pursuant to Federal Funding Accountability and Transparency Act (FFATA) the applicant is required to obtain a DUNS number that will represent a universal identifier for all federal funding assistance. DUNS numbers can be obtained from Dun and Bradstreet at http://fedgov.dnb.com/webform/

79. Applicant's Data Universal Number System (DUNS) Number:
DUNS _____

Pursuant to Federal Funding Accountability and Transparency Act (FFATA) the applicant is required to register with System for Award Management (SAM) and maintain current registration at all times during which the Board loan agreement is active or under consideration by the Board. Register at: https://sam.gov.

80. The applicant has registered and will maintain current SAM registration at all times during which a federal subaward is active or under consideration by the Board.
- ☐ Yes
- ☐ No

81. Federal Awards information:
1. Did applicant receive over 80% of their revenue from Federal Awards last year?
   - ☐ Yes
   - ☐ No
2. Did applicant receive over $25 million in Federal Awards last year?
   - ☐ Yes
   - ☐ No
3. Public does not have access to executive compensation information via SEC or IRS reports?
   - ☐ Yes
   - ☐ No

82. If applicant checked **YES** to **ALL** three boxes in 3 above, applicant is required to disclose the name and compensation of the five most highly compensated officers.

Officer's Name	Officer's Compensation ($)

83. Complete form WRD 213 (http://www.twdb.texas.gov/financial/instructions/index.asp) - Certification Regarding Lobbying

Attached
- ☐ Yes
- ☐ No
- ☐ N/A

Please label each attachment with the number of the pertinent application section (i.e. "Part D5")

84. If applying for CWSRF Equivalency or DWSRF, **attach** the Certification Regarding Debarment, Suspension and Other Responsibility. SRF-404 (http://www.twdb.texas.gov/financial/instructions/index.asp)

Attached ☐ Yes ☐ No ☐ N/A

85. If applying for CWSRF Equivalency or DWSRF, **attach** the Assurances – Construction Programs. EPA-424D (http://www.twdb.texas.gov/financial/instructions/index.asp)

Attached ☐ Yes ☐ No ☐ N/A

86. The applicant must comply with the Davis-Bacon Act regarding prevailing wage rates. The applicant acknowledges that they are aware of, and will abide by, the Davis-Bacon Act requirements.

☐ Yes
☐ No

Further information on the Davis-Bacon requirement is available through the TWDB Guidance document, DB-0156 (http://www.twdb.texas.gov/financial/instructions/index.asp)

All project costs funded by the TWDB through CWSRF Equivalency or DWSRF must comply with the federal Disadvantaged Business Enterprise (DBE) program rules and requirements. The federal DBE program requires a good faith effort to contract with DBE's for all procurements including: professional and non-professional consulting services, equipment, supplies and construction to be funded by federal equivalency dollars. Guidance and forms are found at:
TWDB-0210 (http://www.twdb.texas.gov/financial/instructions/doc/TWDB-0210.pdf)

87. **At a minimum, you must complete and attach** the Applicant Affirmative Steps Certification and Goals. This form is required to obtain a financial assistance commitment.
TWDB-0215 (http://www.twdb.texas.gov/financial/instructions/doc/TWDB-0215.pdf)

Attached ☐ Yes ☐ No

88. If you have already solicited contractors, complete and attach the Affirmative Steps Solicitation Report. This form is required prior to loan closing and release of any funds; therefore, if this question is not applicable at this time, select N/A.
TWDB-216 (http://www.twdb.texas.gov/financial/instructions/doc/TWDB-0216.pdf)

Attached ☐ Yes ☐ No ☐ N/A

Please label each attachment with the number of the pertinent application section (i.e. "Part D5")

89. If you have awarded contracts to contractors, complete and attach the Loan/Grant Participation Summary. This form must be submitted for review prior to loan closing and release of funds. This form is required prior to loan closing and release of any funds; therefore, if this question is not applicable at this time, select N/A.
TWDB-0373 (http://www.twdb.texas.gov/financial/instructions/index.asp)

Attached ☐ Yes ☐ No ☐ N/A

90. All Contractors that have been awarded will need to complete and attach the Prime Contractor Affirmative Steps Certification and Goals This form is required prior to loan closing and release of any funds; therefore, if this question is not applicable at this time, select N/A.
TWDB-217 (http://www.twdb.texas.gov/financial/instructions/doc/TWDB-0217.pdf)

Attached ☐ Yes ☐ No ☐ N/A

Please label each attachment with the number of the pertinent application section (i.e. "Part D5")

Part H: Documentation of "Green" Projects and Project Components

CWSRF and DWSRF Applicants Only

All SRF applicants must complete this section if green benefits are all or part of the project (more than an incidental benefit). Project is defined as the entire project or a stand-alone component of the project. This section is required so that the TWDB may determine whether the project qualifies as "green" pursuant to Environmental Protection Agency (EPA) Guidance.

A project (or project component) is "green" if the primary purpose qualifies under EPA Guidance as one of the following:

a. Green Infrastructure,
b. Water Efficiency-related,
c. Energy Efficiency-related, or
d. Environmentally Innovative.

You must use the Green Project Reserve guidance to complete this section**.** Current guidance may be found at: **Green Project Reserve: Guidance for determining project eligibility**
TWDB-0161 (http://www.twdb.texas.gov/financial/instructions/doc/TWDB-0161.pdf)

91. Does your project or a component of your project qualify as Green, per EPA guidance?
☐ Yes
☐ No

If Yes, Please complete the remainder of Section G.

92. Type of Green Project
☐ Water Efficiency ☐ Energy Efficiency ☐ Green Infrastructure ☐ Environmentally Innovative

93. The correct worksheets must be completed.
Green Project Reserve: CWSRF Green Project Worksheets
TWDB-0162 (http://www.twdb.texas.gov/financial/instructions/doc/TWDB-0162.pdf)
Attached ☐ Yes ☐ No ☐ N/A

Green Project Reserve: DWSRF Green Project Worksheets
TWDB-0163 (http://www.twdb.texas.gov/financial/instructions/doc/TWDB-0163.pdf)
Attached ☐ Yes ☐ No ☐ N/A

TWDB will make the final determination whether your project (or project component) meets federal criteria as "green". You may be required to submit a **business case, utilizing the Green guidance**

Please label each attachment with the number of the pertinent application section (i.e. "Part D5")

Part I: Summary of attachments to application

Following is a list of the documents that may be necessary in order to process this application. While not all of the listed information below may be required for all projects, an applicant should review the application carefully because incomplete applications will not be processed until all of this information has been provided. In addition, please make sure your entity system name appears on every attachment. **Label each attachment with the number of the pertinent application section (i.e. "Part B5").**

Check list for your convenience

Part A **General Information**

- ☐ No. 6 Draft or executed consulting contracts (engineering, financial advisor, bond counsel)
- ☐ No. 12 Existing security document for refinancing

Part B **Legal**

- ☐ No. 17 Resolution (TWDB-0201A)
- ☐ No. 18 Application Affidavit (TWDB-0201)
- ☐ No. 19 Certificate of Secretary (TWDB-201B)
- ☐ No. 20 Water Supply Corporations
  - ☐ Articles of Incorporation
  - ☐ Certificate of incorporation from the Texas Secretary of State
  - ☐ By-laws and any amendments
  - ☐ Certificate of status from the Texas Secretary of State
  - ☐ Certificate of account status from Texas Comptroller
- ☐ No. 21 Resolution/ordinance authorizing the issuance of parity debt
- ☐ No. 22 Certificate of Convenience & Necessity
- ☐ No. 23 Enforcement Actions
- ☐ No. 24 Affidavit of No Objection
- ☐ No. 25 Two copies of the Water Conservation Plan (TWDB-1968 and TWDB-1965)
- ☐ No. 26 Water use surveys
  http://www.twdb.texas.gov/waterplanning/waterusesurvey/index.asp
- ☐ No. 27 Water Loss Audit
  http://www.twdb.texas.gov/conservation/resources/waterloss-resources.asp

Part C **Financial**

- ☐ No. 39 Assessed Values by Classifications
- ☐ No. 40 Direct and Overlapping Tax Table
- ☐ No. 45 Proforma for each year of debt outstanding
- ☐ No. 46 Five year comparative system operating statement.
- ☐ No. 47 Annual audit and management letter
- ☐ No. 49 Outstanding debt schedule
- ☐ No. 52 Service provider contracts

Please label each attachment with the number of the pertinent application section (i.e. "Part D5")

Part D **Engineering**

☐No. 54a Preliminary Engineering Feasibility Report (PEFR)
☐No. 54b Engineering Feasibility Report
Water (TWDB-0555)
Wastewater (TWDB-0556)
☐No. 54c Project Draw Schedule (TWDB-1202)
☐No. 56 Project Map
☐No. 57 Census Tract(s)
☐No. 59 Current and future populations and projected water use or wastewater flows
☐No. 60 Project Cost Estimate Budget (TWDB-1201)
☐No. 61 Wastewater Project Information Form (WRD-253a)
Water Project Information Form (WRD-253d)
☐No. 62 Texas Pollution Discharge Elimination System Permit
☐No. 63 Designated Management Agency (WRD-210)
☐No. 64 If applicant has property rights and permits
a. WRD-208A (Surface Water)
b. WRD-208B (Groundwater)
☐No. 64c Additional Permits
☐No. 65 Site certificate, evidencing land ownership for the project. (ED-101)
☐No. 66 Categorical Exclusion (CE), Finding of No Significant Impact (FONSI), Record of Decision or any other supporting document
☐No. 68 Social or environmental issues

Part E **State Water Implementation Fund for Texas**

☐ No. 72a Draft Bond Ordinance
☐ No. 72b Private Placement Memorandum

Part F **Economically Distressed Areas Program**

☐No. 74 Resolution/ordinance establishing a mandatory hookup policy
☐No. 75 EDAP applicants
☐ Inadequacy documentation
☐ Financial resources documentation
☐ Existence of residences prior to 06/01/2005
☐No. 76 Public health nuisance
☐No. 77 Plats
☐No. 78 EDAP Planning Phase – Facility Engineering Plan/Scope of Services (WRD-023A)

Part G **CWSRF/DWSRF Questions**

☐No. 83 Lobbying Activities (WRD-213)
☐No. 84 Certification Regarding Debarment, Suspension and Other Responsibility Requirements. (SRF-404)
☐No. 85 Assurances – Construction Programs (EPA-424D)
Disadvantaged Business Requirements Guidance (TWDB-0210)
☐No. 87 Affirmative Steps Certification and Goals (TWDB-0215)
☐No. 88 Affirmative Steps Solicitation Report (TWDB-216)
☐No .89 Loan/ Grant Participation Summary (TWDB-0373)
☐No. 90 Prime Contractor Affirmative Steps Certification and Goals (TWDB-217)

Part H **Green Projects**

Guidance (TWDB-0161)
☐No. 93 CWSRF Green Project Worksheets (TWDB-0162)
DWSRF Green Project Worksheets (TWDB-0163)

Please label each attachment with the number of the pertinent application section (i.e. "Part D5")

Part J: Guidance and Forms

Part A. **General Information**

CWSRF – 31 TAC 375
DWSRF – 31 TAC 371
EDAP and SWIFT - 31 TAC 363
For more information visit, http://www.twdb.texas.gov/about/rules/index.asp.

Part E. **Environmental**

State Programs - 31 TAC 363
Drinking Water State Revolving Fund - 31 TAC 371
Clean Water State Revolving Fund / Equivalency - 31 TAC 375
Clean Water State Revolving Fund / Non-Equivalency - 31 TAC 375

Guidelines for Environmental Assessment, Clean Water Non-Equivalency (ED-001A)
Clean Water EID Instructions (SRF-099)
Guidelines for Environmental Assessment, State Participation, DFund, RWAF and WIF, (ED-001B)
Guidelines for Environmental Assessment, EDAP (ED-001C)
Drinking Water EID Instructions (DW-001)

Part G **Green Projects and Project Components**

Green Project Reserve: Guidance for determining project eligibility (TWDB-0161)

LAW OFFICES
McCALL, PARKHURST & HORTON L.L.P.

600 CONGRESS AVENUE
SUITE 1800
AUSTIN, TEXAS 78701-3248
TELEPHONE: 512 478-3805
FACSIMILE: 512 472-0871

717 NORTH HARWOOD
SUITE 900
DALLAS, TEXAS 75201-6587
TELEPHONE: 214 754-9200
FACSIMILE: 214 754-9250

700 N. ST. MARY'S STREET
SUITE 1525
SAN ANTONIO, TEXAS 78205-3503
TELEPHONE: 210 225-2800
FACSIMILE: 210 225-2984

December 20, 2011

Board of Directors
Tarrant Regional Water District,
a Water Control and Improvement District
800 East North Side Drive
Fort Worth, Texas 76102

Ladies and Gentlemen:

You have requested that we act as bond counsel ("Bond Counsel") for Tarrant Regional Water District, a Water Control and Improvement District ("TRWD") in connection with the issuance of bonds, notes, or other obligations, including those issued for refunding purposes and those issued pursuant to contracts with third parties (collectively, the "Bonds"), of TRWD. The purpose of this letter is to set forth mutually agreeable terms for our engagement.

Generally, we will perform all usual and necessary legal services as Bond Counsel in connection with the authorization, issuance and delivery of the Bonds. Specifically, we will prepare and direct the legal proceedings and perform the other necessary legal services with reference to the authorization, issuance and delivery of the Bonds, including the following:

a. Prepare all resolutions and other instruments, including contracts for contract revenue bonds, pursuant to which the Bonds will be authorized, issued, delivered and secured, in cooperation and upon consultation with the Board of Directors of TRWD, its General Manager and staff, TRWD's legal counsel and the financial advisors and/or the underwriters and their legal counsel, and any other advisors and consultants of TRWD.

b. Review and consult with respect to contracts which are to provide specifically the source of revenues for the payment and security of any Bonds.

c. Review and consult with respect to all other matters and transactions that bear on the security of the Bonds.

d. With reference to the preparations for and authorization and issuance of the Bonds, attend meetings to the extent required or requested.

FINANCIAL ADVISORY AGREEMENT

This Financial Advisory Agreement (the "Agreement") is made and entered into by and between Tarrant Regional Water District, A Water Control and Improvement District ("Issuer") and First Southwest Company ("FSC") effective as of the date executed by the Issuer as reflected on the signature page hereof.

WITNESSETH:

WHEREAS, the Issuer will have under consideration from time to time the authorization and issuance of indebtedness in amounts and forms which cannot presently be determined and, in connection with the authorization, sale, issuance and delivery of such indebtedness, Issuer desires to retain an independent financial advisor; and

WHEREAS, the Issuer desires to obtain the professional services of FSC to advise the Issuer regarding the issuance and sale of certain evidences of indebtedness or debt obligations that may be authorized and issued or otherwise created or assumed by the Issuer (hereinafter referred to collectively as the "Debt Instruments") from time to time during the period in which this Agreement shall be effective; and

WHEREAS, FSC is willing to provide its professional services and its facilities as financial advisor in connection with all programs of financing as may be considered and authorized by Issuer during the period in which this Agreement shall be effective.

NOW, THEREFORE, the Issuer and FSC, in consideration of the mutual covenants and agreements herein contained and other good and valuable consideration, do hereby agree as follows:

SECTION I
DESCRIPTION OF SERVICES

Upon the request of an authorized representative of the Issuer, FSC agrees to perform the financial advisory services stated in the following provisions of this Section I; and for having rendered such services, the Issuer agrees to pay to FSC the compensation as provided in Section V hereof.

A. Financial Planning. At the direction of Issuer, FSC shall:

1. Survey and Analysis. Conduct a survey of the financial resources of the Issuer to determine the extent of its capacity to authorize, issue and service any Debt Instruments contemplated.

1. Method of Sale. Evaluate the particular financing being contemplated, giving consideration to the complexity, market acceptance, rating, size and structure in order to make a recommendation as to an appropriate method of sale, and:

a. If the Debt Instruments are to be sold by an advertised competitive sale, FSC will:

(1) Supervise the sale of the Debt Instruments, reserving the right, alone or in conjunction with others, to submit a bid for any Debt Instruments issued under this Agreement which the Issuer advertises for competitive bids; however, in keeping with the provisions of Rule G-23 of the Municipal Securities Rulemaking Board, FSC will request and obtain written consent to bid prior to submitting a bid, in any instance wherein FSC elects to bid, for any installment of such Debt Instruments;

(2) Disseminate information to prospective bidders, organize such informational meetings as may be necessary, and facilitate prospective bidders' efforts in making timely submission of proper bids;

(3) Assist the staff of the Issuer in coordinating the receipt of bids, the safekeeping of good faith checks and the tabulation and comparison of submitted bids; and

(4) Advise the Issuer regarding the best bid and provide advice regarding acceptance or rejection of the bids.

b. If the Debt Instruments are to be sold by negotiated sale, FSC will:

(1) Recommend for Issuer's final approval and acceptance one or more investment banking firms as managers of an underwriting syndicate for the purpose of negotiating the purchase of the Debt Instruments.

(2) Cooperate with and assist any selected managing underwriter and their counsel in connection with their efforts to prepare any Official Statement or Offering Memorandum. FSC will cooperate with and assist the underwriters in the preparation of a bond purchase contract, an underwriters agreement and other related documents. The costs incurred in such efforts, including the printing of the documents, will be paid in accordance with the terms of the Issuer's agreement with the underwriters, but shall not be or become an obligation of FSC, except to the extent specifically

provided otherwise in this Agreement or assumed in writing by FSC.

(3) Assist the staff of the Issuer in the safekeeping of any good faith checks, to the extent there are any such, and provide a cost comparison, for both expenses and interest which are suggested by the underwriters, to the then current market.

(4) Advise the Issuer as to the fairness of the price offered by the underwriters.

2. Offering Documents. Coordinate the preparation of the notice of sale and bidding instructions, official statement, official bid form and such other documents as may be required and submit all such documents to the Issuer for examination, approval and certification. After such examination, approval and certification, FSC shall provide the Issuer with a supply of all such documents sufficient to its needs and distribute by mail sets of the same to prospective purchasers of the Debt Instruments. Also, FSC shall provide copies of the final Official Statement to the purchaser of the Debt Instruments in accordance with the Notice of Sale and Bidding Instructions.

3. Credit Ratings. Make recommendations to the Issuer as to the advisability of obtaining a credit rating, or ratings, for the Debt Instruments and, when directed by the Issuer, coordinate the preparation of such information as may be appropriate for submission to the rating agency, or agencies. In those cases where the advisability of personal presentation of information to the rating agency, or agencies, may be indicated, FSC will arrange for such personal presentations, utilizing such composition of representatives from the Issuer as may be finally approved or directed by the Issuer.

4. Trustee, Paying Agent, Registrar. Upon request, counsel with the Issuer in the selection of a Trustee and/or Paying Agent/Registrar for the Debt Instruments, and assist in the negotiation of agreements pertinent to these services and the fees incident thereto.

5. Financial Publications. When appropriate, advise financial publications of the forthcoming sale of the Debt Instruments and provide them with all pertinent information.

6. Consultants. After consulting with and receiving directions from the Issuer, arrange for such reports and opinions of recognized independent consultants as may be appropriate for the successful marketing of the Debt Instruments.

7. Auditors. In the event formal verification by an independent auditor of any calculations incident to the Debt Instruments is required, make arrangements for such services.

8. Issuer Meetings. Attend meetings of the governing body of the Issuer, its staff, representatives or committees as requested at all times when FSC may be of assistance or service and the subject of financing is to be discussed.

9. Printing. To the extent authorized by the Issuer, coordinate all work incident to printing of the offering documents and the Debt Instruments.

10. Bond Counsel. Maintain liaison with Bond Counsel in the preparation of all legal documents pertaining to the authorization, sale and issuance of the Debt Instruments.

11. Changes in Laws. Provide to the Issuer copies of proposed or enacted changes in federal and state laws, rules and regulations having, or expected to have, a significant effect on the municipal bond market of which FSC becomes aware in the ordinary course of its business, it being understood that FSC does not and may not act as an attorney for, or provide legal advice or services to, the Issuer.

12. Delivery of Debt Instruments. As soon as a bid for the Debt Instruments is accepted by the Issuer, coordinate the efforts of all concerned to the end that the Debt Instruments may be delivered and paid for as expeditiously as possible and assist the Issuer in the preparation or verification of final closing figures incident to the delivery of the Debt Instruments.

13. Debt Service Schedule; Authorizing Resolution. After the closing of the sale and delivery of the Debt Instruments, deliver to the Issuer a schedule of annual debt service requirements for the Debt Instruments and, in coordination with Bond Counsel, assure that the paying agent/registrar and/or trustee has been provided with a copy of the authorizing ordinance, order or resolution.

SECTION II
OTHER AVAILABLE SERVICES

In addition to the services set forth and described in Section I hereinabove, FSC agrees to make available to Issuer the following services, when so requested by the Issuer and subject to the agreement by Issuer and FSC regarding the compensation, if any, to be paid for such services, it being understood and

agreed that the services set forth in this Section II shall require further agreement as to the compensation to be received by FSC for such services:

1. Investment of Funds. From time to time, as an incident to the other services provided hereunder as financial advisor, FSC may purchase such investments as may be directed and authorized by Issuer to be purchased, it being understood that FSC will be compensated in the normal and customary manner for each such transaction. In any instance wherein FSC may become entitled to receive fees or other compensation in any form from a third party with respect to these investment activities on behalf of Issuer, FSC will disclose to Issuer the nature and, to the extent such is known, the amount of any such compensation so that Issuer may consider the information in making its investment decision. It is understood and agreed that FSC is a duly licensed broker/dealer and is affiliated with First Southwest Asset Management, Inc. ("FSAMI"), a duly registered investment advisor. Issuer may, from time to time, utilize the broker/dealer and/or investment advisory services of FSC and/or FSAMI with respect to matters which do not involve or affect the investment of bond proceeds or the financial advisory services referenced in this Agreement. The terms and conditions of the engagement of FSC and/or FSAMI to provide such services shall not be affected by the terms of this Agreement.

2. Exercising Calls and Refunding. Provide advice and assistance with regard to exercising any call and/or refunding of any outstanding Debt Instruments.

3. Capital Improvements Programs. Provide advice and assistance in the development of any capital improvements programs of the Issuer.

4. Long-Range Planning. Provide advice and assistance in the development of other long-range financing plans of the Issuer.

5. Post-Sale Services. Subsequent to the sale and delivery of Debt Instruments, review the transaction and transaction documentation with legal counsel for the Issuer, Bond Counsel, auditors and other experts and consultants retained by the Issuer and assist in developing appropriate responses to legal processes, audit procedures, inquiries, intemal reviews and similar matters.

SECTION III
TERM OF AGREEMENT

This Agreement shall become effective as of the date executed by Issuer as reflected on the signature page hereof and, unless terminated by either party pursuant to Section IV of this Agreement, shall remain

in effect thereafter for a period of five (5) years from such date. Unless FSC or Issuer shall notify the other party in writing at least thirty (30) days in advance of the applicable anniversary date that this Agreement will not be renewed, this Agreement will be automatically renewed on the fifth anniversary of the date hereof for an additional one (1) year period and thereafter will be automatically renewed on each anniversary date for successive one (1) year periods.

SECTION IV
TERMINATION

This Agreement may be terminated with or without cause by the Issuer or FSC upon the giving of at least thirty (30) days' prior written notice to the other party of its intention to terminate, specifying in such notice the effective date of sucb termination. In the event of such termination, it is understood and agreed that only the amounts due FSC for services provided and expenses incurred to the date of termination will be due and payable. No penalty will be assessed for termination of this Agreement.

SECTION V
COMPENSATION AND EXPENSE REIMBURSEMENT

The fees due to FSC for the services set forth and described in Section I of this Agreement with respect to each issuance of Debt Instruments during the term of this Agreement shall be calculated in accordance with the schedule set forth on Appendix A attached hereto. Unless specifically provided otherwise on Appendix A or in a separate written agreement between Issuer and FSC, such fees, together with any other fees as may have been mutually agreed upon and all expenses for which FSC is entitled to reimbursement, shall become due and payable concurrently with the delivery of the Debt Instruments to the purchaser.

SECTION VI
MISCELLANEOUS

1. Choice of Law. This Agreement shall be construed and given effect in accordance with the laws of the State of Texas.

2. Binding Effect; Assignment. This Agreement shall be binding upon and inure to the benefit of the Issuer and FSC, their respective successors and assigns; provided however, neither party hereto may assign or transfer any of its rights or obligations hereunder without the prior written consent of the other party.

3. Entire Agreement. This instrument contains the entire agreement between the parties relating to the rights herein granted and obligations herein assumed. Any oral or written representations or modifications concerning this Agreement shall be of no force or effect except for a subsequent modification in writing signed by all parties hereto.

FIRST SOUTHWEST COMPANY

By: _____
Hill A. Feinberg, Chairman and
Chief Executive Officer

By: _____
David K. Medanich
Senior Vice President

TARRANT REGIONAL WATER DISTRICT

By: _____
Title: General Manager
Date: 5/13/99

ATTEST:

_____
Secretary

APPENDIX A

The fees due FSC will not exceed those contained in our customary fee schedule as listed below.

$10.00 per $1,000 ($7,500 Minimum)			for the first	$	750,000	of bonds issued
plus	$ 7.50	per $1,000	for the next	$	750,000	of bonds issued
plus	$ 5.00	per $1,000	for the next	$	3,500,000	of bonds issued
plus	$ 3.00	per $1,000	for the next	$	5,000,000	of bonds issued
plus	$ 2.00	per $1,000	for the next	$	10,000,000	of bonds issued
plus	$ 1.50	per $1,000	over the next	$	20,000,000	and thereafter

The above charges shall be multiplied by 1.25 times for the completion of an application to a federal or state government agency or for the issuance of revenue bonds or refunding bonds, reflecting the additional services required.

The charges for ancillary services, including computer structuring and official statement printing, shall be levied only for those services which are reasonably necessary in completing the transaction and which are reasonable in amount, unless such charges were incurred at the specific direction of the Issuer.

The payment of charges for financial advisory services described in Section I of the foregoing Agreement shall be contingent upon the delivery of bonds and shall be due at the time that bonds are delivered. The payment of charges for services described in Section II of the foregoing Agreement shall be due and payable in accordance with the mutual agreement therefor between FSC and Issuer.

The Issuer shall be responsible for the following expenses, if and when applicable, whether they are charged to the Issuer directly as expenses or charged to the Issuer by FSC as reimbursable expenses:

Bond counsel
Bond printing
Bond ratings
Computer structuring
Credit enhancement
CPA fees for refunding
Official statement preparation and printing
Paying agent/registrar/trustee
Travel expenses
Underwriter and underwriters counsel
Miscellaneous, including copy, delivery, and phone charges

The payment of reimbursable expenses that FSC has assumed on behalf of the Issuer shall NOT be contingent upon the delivery of bonds and shall be due at the time that services are rendered and payable upon receipt of an invoice therefor submitted by FSC.

Part B #17

TWDB-0201a
Rev 1/3/2014

Application Filing and Authorized Representative Resolution (WRD-201a)

A RESOLUTION by the Board of Directors of the Tarrant Regional Water District requesting financial assistance from the Texas Water Development Board; authorizing the filing of an application for assistance; and making certain findings in connection therewith.

BE IT RESOLVED BY THE Board of Directors OF THE Tarrant Regional Water District:

SECTION 1: That an application is hereby approved and authorized to be filed with the Texas Water Development Board seeking financial assistance in an amount not to exceed $440,000,000 to provide for the costs of Integrated Pipeline Project (Tarrant Regional Water District - $300,000,000 and City of Dallas IPL Project - $140,000,000)

SECTION 2: That Board President, General Manager or Director of Finance be and is hereby designated the authorized representative of the Tarrant Regional Water District for purposes of furnishing such information and executing such documents as may be required in connection with the preparation and filing of such application for financial assistance and the rules of the Texas Water Development Board.

SECTION 3: That the following firms and individuals are hereby authorized and directed to aid and assist in the preparation and submission of such application and appear on behalf of and represent the Tarrant Regional Water District before any hearing held by the Texas Water Development Board on such application, to wit:

Financial Advisor: David Medanich or Laura Alexander
First Southwest Company
Fort Worth Texas

Engineer: _____

Bond Counsel: Alan Raynor
McCall, Parkhurst & Horton L.L.P.
Dallas Texas

PASSED AND APPROVED, this the 19 day of May, 2015.

ATTEST: Martha V. Leonard

By: Victor W. Henderson

(Seal)

Part B #18

TWDB-0201
Revised 2/21/2013

Application Affidavit (WRD-201)

THE STATE OF TEXAS §
COUNTY OF Tarrant §
APPLICANT Tarrant Regional Water District §

BEFORE ME, the undersigned, a Notary Public in and for the State of Texas, on this day personally appeared _____ as the Authorized Representative of the Tarrant Regional Water District, who being by me duly sworn, upon oath says that:

1. the decision by the Tarrant Regional Water District (authority, city, county, corporation, district) to request financial assistance from the Texas Water Development Board ("Board") was made in a public meeting held in accordance with the Open Meetings Act (Government Code, §551.001, et seq,) and after providing all such notice as required by such Act as is applicable to the Tarrant Regional Water District (authority, city, county, corporation, district) ;

2. the information submitted in the application is true and correct according to my best knowledge and belief;

3. the Tarrant Regional Water District (authority, city, county, corporation, district) has no pending, threatened, or outstanding judgments, orders, fines, penalties, taxes, assessment or other enforcement or compliance issue of any kind or nature by the Environmental Protection Agency, Texas Commission on Environmental Quality, Texas Comptroller, Texas Secretary of State, or any other federal, state or local government, except for the following (if no such outstanding compliance issues, write in "none"):

none.

4. the Tarrant Regional Water District (authority, city, county, corporation, district) warrants compliance with the representations made in the application in the event that the Board provides the financial assistance; and

5. the Tarrant Regional Water District (authority, city, county, corporation, district) will comply with all applicable federal laws, rules, and regulations as well as the laws of this state and the rules and regulations of the Board.

Victor W. Henderson
Official Representative

Title: President

SWORN TO AND SUBSCRIBED BEFORE ME, by Victor W. Henderson,
this 19th day of May, 2015.

(NOTARY SEAL) NANCY L. KING NOTARY PUBLIC STATE OF TEXAS 05-14-2016

Nancy L. King
Notary Public, State of Texas

Part B # 19

TWDB—0201B
Revised 02/21/2013

Application Resolution - Certificate of Secretary (WRD-201b)

THE STATE OF TEXAS §
COUNTY OF Tarrant §
APPLICANT Tarrant Regional Water District §

I, the undersigned, Secretary of the Tarrant Regional Water District Texas, DO HEREBY CERTIFY as follows:

1. That on the 19 day of May, 20 15, a regular/special meeting of the Tarrant Regional Water District was held at a meeting place within the City; the duly constituted members of the Board of Directors being as follows:

Victor Henderson, Jack Stevens, Martha Leonard, James Lane and Mary Kelleher

and all of said persons were present at said meeting, except the following:

none

Among other business considered at said meeting, the attached resolution entitled:

"A RESOLUTION by the Board of Directors of the Tarrant Regional Water District requesting financial participation from the Texas Water Development Board; authorizing the filing of an application for financial participation; and making certain findings in connection therewith."

was introduced and submitted to the Board of Directors for passage and adoption. After presentation and due consideration of the resolution, and upon a motion made by Jim Lane and seconded by Marty Leonard, the resolution was duly passed and adopted by the TRWD Board by the following vote:

5 voted "For" 0 voted "Against" 0 abstained

all as shown in the official Minutes of the Tarrant Regional Water District for the meeting held on the aforesaid date.

2. That the attached resolution is a true and correct copy of the original on file in the official records of the Tarrant Regional Water District; the duly qualified and acting members of the Board of Directors on the date of the aforesaid meeting are those persons shown above and, according to the records of my office, advance notice of the time, place and purpose of said meeting was given to each member of the Board of Directors; and that said meeting, and deliberation of the aforesaid public business, was open to the public and written notice of said meeting, including the subject of the above entitled resolution, was posted and given in advance thereof in compliance with the provisions of Chapter 551 of the Texas Government Code.

IN WITNESS WHEREOF, I have hereunto signed my name officially and affixed the seal of said Tarrant Regional Water District this the 19 of May, 20 15.

(SEAL)

Martha V. Leonard
Secretary

Part B # 21

2014

CERTIFICATE FOR RESOLUTION

THE STATE OF TEXAS :
COUNTY OF TARRANT :
TARRANT REGIONAL WATER DISTRICT,
A WATER CONTROL AND IMPROVEMENT DISTRICT :

We, the undersigned officers of the Board of Directors of said District, hereby certify as follows:

1. The Board of Directors of said District convened in REGULAR MEETING ON THE 21ST OF JANUARY, 2014, at the regular designated meeting place, and the roll was called of the duly constituted officers and members of said Board, to-wit:

Victor W. Henderson, President
Jack R. Stevens, Vice President
Martha V. Leonard, Secretary
James W. Lane, Secretary Pro Tem
Mary Kelleher, Director

and all of said persons were present, except the following absentees: none, thus constituting a quorum. Whereupon, among other business the following was transacted at said Meeting: a written

RESOLUTION AUTHORIZING THE ISSUANCE, SALE, AND DELIVERY OF TARRANT REGIONAL WATER DISTRICT, A WATER CONTROL AND IMPROVEMENT DISTRICT, WATER TRANSMISSION FACILITIES CONTRACT REVENUE BONDS (CITY OF DALLAS PROJECT), SERIES 2014, PLEDGING REVENUES FOR THE PAYMENT OF THE BONDS, APPROVING AN OFFICIAL STATEMENT, AND AUTHORIZING OTHER INSTRUMENTS AND PROCEDURES RELATING THERETO

was duly introduced for the consideration of said Board and read in full. It was then duly moved and seconded that said Resolution be passed; and, after due discussion, said motion, carrying with it the passage of said Resolution, prevailed and carried by the following vote:

AYES: All members of said Board shown present above voted "Aye"; except Kelleher.

NOES: 0.

ABSTENTION: 1

2. That a true, full, and correct copy of the aforesaid Resolution passed at the Meeting described in the above and foregoing paragraph is attached to and follows this Certificate; that said Resolution has been duly recorded in said Board's minutes of said Meeting; that the above and foregoing paragraph is a true, full, and correct excerpt from said Board's minutes of said Meeting pertaining to the passage of said Resolution; that the persons named in the above and foregoing paragraph are the duly chosen, qualified, and acting officers and members of said Board as indicated therein; that each of the officers and members of said Board was duly and sufficiently notified officially and personally, in advance, of the time, place, and purpose of the aforesaid Meeting, and that said Resolution would be introduced and considered for passage at said Meeting, and each of said officers and members consented, in advance, to the holding of said Meeting for such purpose; and that said Meeting was open to the public, and public notice of the time, place, and purpose of said Meeting was given all as required by Chapter 551, Texas Government Code.

SIGNED AND SEALED the 21st day of January, 2014.

Martha V. Lemm
Secretary, Board of Directors

Victor Henderson
President, Board of Directors

(SEAL)

RESOLUTION AUTHORIZING THE ISSUANCE, SALE, AND DELIVERY OF TARRANT REGIONAL WATER DISTRICT, A WATER CONTROL AND IMPROVEMENT DISTRICT, WATER TRANSMISSION FACILITIES CONTRACT REVENUE BONDS (CITY OF DALLAS PROJECT), SERIES 2014, PLEDGING REVENUES FOR THE PAYMENT OF THE BONDS, APPROVING AN OFFICIAL STATEMENT, AND AUTHORIZING OTHER INSTRUMENTS AND PROCEDURES RELATING THERETO

THE STATE OF TEXAS §
COUNTY OF TARRANT §
TARRANT REGIONAL WATER DISTRICT,
A WATER CONTROL AND IMPROVEMENT DISTRICT §

WHEREAS, Tarrant Regional Water District, a Water Control and Improvement District, (formerly known as "Tarrant County Water Control and Improvement District Number One") (the "Issuer" or "District") is a political subdivision of the State of Texas, being a conservation and reclamation district created and functioning under Article 16, Section 59, of the Texas Constitution, pursuant to the general laws of the State of Texas, including Chapters 49 and 51, Texas Water Code, and pursuant to the provisions of Chapter 268, Acts of 1957, 55th Legislature of Texas, Regular Session, as amended (collectively, the "District Act"); and

WHEREAS, a Water Transmission Facilities Financing Agreement, dated November 16, 2010 (the "Contract"), has been duly executed by the Issuer and the City of Dallas, Texas (the "City"), with respect to the acquisition, construction, and financing of an integrated pipeline project (as defined therein and as used herein, the "Project").

WHEREAS, the Issuer will authorize the Series 2014 Bonds (hereinafter defined) pursuant to the Contract, the District Act, Chapter 1371, Texas Government Code, as amended, and other applicable laws; and

WHEREAS, the meeting was open to the public and public notice of the time, place and purpose of said meeting was given pursuant to Chapter 551, Texas Government Code.

THEREFORE, BE IT RESOLVED BY THE BOARD OF DIRECTORS OF TARRANT REGIONAL WATER DISTRICT, A WATER CONTROL AND IMPROVEMENT DISTRICT, THAT:

Section 1. AMOUNT AND PURPOSE OF THE BONDS. The bond or bonds of the Issuer are hereby authorized to be issued and delivered, in one or more series, in an aggregate principal amount not to exceed $230,000,000, and in the manner hereinafter provided, for the purpose of obtaining funds to (i) pay for design, acquisition, and construction costs related to the Dallas Project Component (as defined in the Contract) of the Project, (ii) fund a reserve fund for the Series 2014 Bonds, and (iii) pay costs of issuance of the Series 2014 Bonds.

Section 2. DESIGNATION OF THE BONDS. Each bond issued pursuant to this Resolution shall be designated: "TARRANT REGIONAL WATER DISTRICT, A WATER CONTROL AND IMPROVEMENT DISTRICT, WATER TRANSMISSION FACILITIES CONTRACT REVENUE BOND (CITY OF DALLAS PROJECT), SERIES 2014." Initially there

shall be issued, sold, and delivered hereunder a single fully registered bond, without interest coupons, payable in installments of principal (the "Initial Bond"), but the Initial Bond may be assigned and transferred and/or converted into and exchanged for a like aggregate amount of fully registered bonds, without interest coupons, having serial maturities, and in the denomination or denominations of $5,000 or any integral multiple of $5,000, all in the manner hereinafter provided. The term "Series 2014 Bonds" as used in this Resolution shall mean and include collectively the Initial Bond and all substitute bonds exchanged therefor, as well as all other substitute bonds and replacement bonds issued pursuant hereto, and the term "Series 2014 Bond" shall mean any of the Series 2014 Bonds.

Section 3. INITIAL DATE, DENOMINATION, NUMBER, MATURITIES, INITIAL REGISTERED OWNER, AND CHARACTERISTICS OF THE INITIAL BOND. (a) As authorized by Chapter 1371, Texas Government Code, as amended, the President of the Board of Directors, the General Manager, and the Finance Director of the Issuer are each hereby designated as an "Authorized Officer" of the Issuer, and each is hereby authorized, appointed, and designated as the officer or employee of the Issuer authorized to act on behalf of the Issuer, which actions shall be evidenced by a certificate executed by such Authorized Officer (the "Approval Certificate") for a period not to extend beyond July 15, 2014, in the sale, whether by bid or negotiation, and delivery of the Series 2014 Bonds and in carrying out the other procedures specified in this Resolution, including the use of a book-entry only system with respect to the Series 2014 Bonds and the execution of an appropriate letter of representations if deemed appropriate, the determining and fixing of the date and the date of delivery of the Series 2014 Bonds, any additional or different designation or title by which the Bond shall be known, the price at which the Series 2014 Bonds will be sold (but in no event less than 97% of the principal amount of the Series 2014 Bonds), the principal amount (not exceeding $230,000,000) of the Series 2014 Bonds, the amount of each maturity of principal thereof (with annual payments of principal and interest not greater than 10% more or less in any one year, commencing with the year 2015, than any other year), the due date of each such maturity (but in no event later than September 1, 2044), the rate of interest to be bome by each such maturity (but in no event to result in the net effective interest rate on the Series 2014 Bonds exceeding 5.00%), the initial interest payment date, the date or dates of optional redemption thereof, any mandatory sinking fund redemption provisions, and approving modifications to this Resolution and executing such instruments, documents and agreements as may be necessary with respect thereto, and all other matters relating to the issuance, sale and delivery of the Series 2014 Bonds. It is further provided, however, that, notwithstanding the foregoing provisions, the Series 2014 Bonds shall not be delivered unless the Series 2014 Bonds are then rated by a nationally recognized rating agency in one of the four highest rating categories for a long-term instrument.

(b) The Initial Bond is hereby authorized to be issued, sold, and delivered hereunder as a single fully registered Series 2014 Bond, without interest coupons, in the denomination and aggregate principal amount set forth in the Approval Certificate (not exceeding $230,000,000) numbered TR-1, payable in annual installments of principal to the initial registered owner thereof or to the registered assignee or assignees of said Series 2014 Bond or any portion or portions thereof (in each case, the "registered owner"), with the annual installments of principal of the Initial Bond to be payable on the dates, respectively, and in the principal amounts, respectively, and may and shall be prepaid or redeemed prior to the respective scheduled due dates of installments of principal thereof, all as set forth in the Approval Certificate.

(c) The Initial Bond (i) may and, if so provided in the Approval Certificate, shall be prepaid or paid on the respective scheduled due dates of installments of principal thereof, (ii) may be assigned and transferred, (iii) may be converted and exchanged for other bonds, (iv) shall have the characteristics, and (v) shall be signed and sealed, and the principal of and interest on the Initial Bond shall be payable, all as provided, and in the manner required or indicated, in the FORM OF INITIAL BOND set forth in this Resolution.

Section 4. INTEREST. The unpaid principal balance of the Initial Bond shall bear interest from the dated date thereof to the respective scheduled due dates, or to the respective dates of prepayment or redemption, of the installments of principal of the Initial Bond, and such interest shall be payable in the manner, at the rates, and on the dates, respectively, as provided in the FORM OF INITIAL BOND, set forth in this Resolution.

Section 5. FORM OF INITIAL BOND. The form of the Initial Bond, including the form of Registration Certificate of the Comptroller of Public Accounts of the State of Texas to be endorsed on the Initial Bond, shall be substantially as follows:

FORM OF INITIAL BOND

NO. TR-1 $_____*

UNITED STATES OF AMERICA
STATE OF TEXAS
TARRANT REGIONAL WATER DISTRICT,
A WATER CONTROL AND IMPROVEMENT DISTRICT,
WATER TRANSMISSION FACILITIES CONTRACT REVENUE BOND
(CITY OF DALLAS PROJECT),
SERIES 2014

TARRANT REGIONAL WATER DISTRICT, A WATER CONTROL AND IMPROVEMENT DISTRICT (the "Issuer"), being a political subdivision of the State of Texas, hereby promises to pay to _____* or to the registered assignee or assignees of this Bond or any portion or portions hereof (in each case, the "registered owner") the aggregate principal amount of _____* and __/100 Dollars ($_____*) in annual installments of principal due and payable on September 1 in each of the years, in the respective principal amounts, and bearing interest at the respective interest rates, as set forth in the following schedule:

*From Approval Certificate.

Year*	Principal Amount*	Interest Rates*	Year*	Principal Amount*	Interest Rates*
	$	%		$	%

Interest will be payable, calculated on the basis of a 360-day year composed of twelve 30-day months, from the date of initial delivery of this Bond to the Underwriters (as defined in the Bond Resolution (hereinafter defined)), on the balance of each such installment of principal, with said interest being payable semiannually on each March 1 and September 1, commencing _____*, while this Bond or any portion hereof is outstanding and unpaid.

THE INSTALLMENTS OF PRINCIPAL OF AND THE INTEREST ON this Bond are payable in lawful money of the United States of America, without exchange or collection charges. The installments of principal and the interest on this Bond are payable to the registered owner hereof through the services of BOKF, NA dba BANK OF TEXAS, DALLAS, TEXAS, which is the "Paying Agent/Registrar" for this Bond. Payment of all principal of and interest on this Bond shall be made by the Paying Agent/Registrar to the registered owner hereof on each principal and/or interest payment date by check, dated as of such date, drawn by the Paying Agent/Registrar on, and payable solely from, funds of the Issuer required by the resolution authorizing the issuance of this Bond (the "Bond Resolution") to be on deposit with the Paying Agent/Registrar for such purpose as hereinafter provided; and such check shall be sent by the Paying Agent/Registrar by United States mail, first-class postage prepaid, on each such principal and/or interest payment date, to the registered owner hereof, at the address of the registered owner, as it appeared at the close of business on the 15th day of the month next preceding each such date (the "Record Date") on the Registration Books kept by the Paying Agent/ Registrar, as hereinafter described. The Issuer covenants with the registered owner of this Bond that on or before each principal and/or interest payment date for this Bond it will make available to the Paying Agent/Registrar, from the "Interest and Redemption Fund" created by the Bond Resolution, the amounts required to provide for the payment, in immediately available funds, of all principal of and interest on this Bond, when due.

IF THE DATE for the payment of the principal of or interest on this Bond shall be a Saturday, Sunday, a legal holiday, or a day on which banking institutions in the city where the Paying Agent/Registrar is located are authorized by law or executive order to close, then the date for such payment shall be the next succeeding day which is not such a Saturday, Sunday, legal holiday, or day on which banking institutions are authorized to close; and payment on such date shall have the same force and effect as if made on the original date payment was due.

THIS BOND has been authorized in accordance with the Constitution and laws of the State of Texas in the principal amount of $_____*, for the purpose of obtaining funds to (i) pay for design, acquisition, and construction costs related to the Dallas Project Component of the Project,

*From Approval Certificate.

as such terms are defined in the Bond Resolution, consisting generally of a portion of the share of the City of Dallas, Texas (the "City") of the costs of an integrated pipeline to serve the City and the Issuer, (ii) fund a reserve fund for this Bond, and (iii) pay costs of issuance of this Bond.

ON _____ 1, ____*, or any date thereafter, the unpaid installments of principal of this Bond may be prepaid or redeemed prior to their scheduled due dates, at the option of the Issuer, with funds derived from any available source, as a whole, or in part, and, if in part, the Issuer shall select and designate the installment or installment of principal, and the amount that is to be redeemed, and if less than a whole principal installment is to be called, the Issuer shall direct the Paying Agent/Registrar to call by lot or other customary method of random selection the portion of the principal installment to be redeemed (only in an integral multiple of $5,000), at the redemption price of the principal amount to be prepaid or redeemed, plus accrued interest to the date fixed for prepayment or redemption.

**[THE PRINCIPAL INSTALLMENTS OF THIS BOND maturing on September 1, ____ and September 1, ____ are subject to mandatory prepayment or redemption prior to maturity in part, at a price equal to the principal amount of this Bond or portions hereof to be prepaid or redeemed plus accrued interest to the date of prepayment or redemption, on September 1 in the each of years and in the amounts as follows:

Principal Installment due on September 1, ____

Years	Amounts

Principal Installment due on September 1, ____

Years	Amounts

The amount of any principal installment of this Bond required to be prepaid or redeemed pursuant to the operation of such mandatory prepayment or redemption provisions shall be reduced, at the option of the Issuer, by the principal amount of such principal installment of this Bond which, at least 50 days prior to the mandatory prepayment or redemption date (1) shall have been acquired by the Issuer at a price not exceeding such principal amount plus accrued interest to the date of purchase thereof, (2) shall have been purchased by the Paying Agent/Registrar at the request of the Issuer at a price not exceeding such principal amount plus accrued interest to the date of purchase,

* From Approval Certificate.
** From Approval Certificate, if applicable.

or (3) shall have been prepaid or redeemed pursuant to the optional prepayment or redemption provisions and not theretofore credited against a mandatory prepayment or redemption requirement.]

AT LEAST 30 days prior to the date fixed for any such prepayment or redemption a written notice of such prepayment or redemption shall be mailed by the Paying Agent/Registrar to the registered owner hereof. By the date fixed for any such prepayment or redemption due provision shall be made by the Issuer with the Paying Agent/Registrar for the payment of the required prepayment or redemption price for this Bond or the portion hereof which is to be so prepaid or redeemed, plus accrued interest thereon to the date fixed for prepayment or redemption. If such written notice of prepayment or redemption is given, and if due provision for such payment is made, all as provided above, this Bond, or the portion thereof which is to be so prepaid or redeemed, thereby automatically shall be treated as prepaid or redeemed prior to its scheduled due date, and shall not bear interest after the date fixed for its prepayment or redemption, and shall not be regarded as being outstanding except for the right of the registered owner to receive the prepayment or redemption price plus accrued interest to the date fixed for prepayment or redemption from the Paying Agent/Registrar out of the funds provided for such payment. The Paying Agent/Registrar shall record in the Registration Books all such prepayments or redemptions of principal of this Bond or any portion hereof.

THIS BOND, to the extent of the unpaid or unredeemed principal balance hereof, or any unpaid and unredeemed portion hereof in any integral multiple of $5,000, may be assigned by the initial registered owner hereof and shall be transferred only in the Registration Books of the Issuer kept by the Paying Agent/Registrar acting in the capacity of registrar for the Bonds, upon the terms and conditions set forth in the Bond Resolution. Among other requirements for such transfer, this Bond must be presented and surrendered to the Paying Agent/ Registrar for cancellation, together with proper instruments of assignment, in form and with guarantee of signatures satisfactory to the Paying Agent/Registrar, evidencing assignment by the initial registered owner of this Bond, or any portion or portions hereof in any integral multiple of $5,000, to the assignee or assignees in whose name or names this Bond or any such portion or portions hereof is or are to be transferred and registered. Any instrument or instruments of assignment satisfactory to the Paying Agent/Registrar may be used to evidence the assignment of this Bond or any such portion or portions hereof by the initial registered owner hereof. A new bond or bonds payable to such assignee or assignees (which then will be the new registered owner or owners of such new Bond or Bonds) or to the initial registered owner as to any portion of this Bond which is not being assigned and transferred by the initial registered owner, shall be delivered by the Paying Agent/Registrar in conversion of and exchange for this Bond or any portion or portions hereof, but solely in the form and manner as provided in the next paragraph hereof for the conversion and exchange of this Bond or any portion hereof. The registered owner of this Bond shall be deemed and treated by the Issuer and the Paying Agent/Registrar as the absolute owner hereof for all purposes, including payment and discharge of liability upon this Bond to the extent of such payment, and the Issuer and the Paying Agent/Registrar shall not be affected by any notice to the contrary.

AS PROVIDED above and in the Bond Resolution, this Bond, to the extent of the unpaid or unredeemed principal balance hereof, may be converted into and exchanged for a like aggregate principal amount of fully registered bonds, without interest coupons, payable to the assignee or assignees duly designated in writing by the initial registered owner hereof, or to the initial registered

owner as to any portion of this Bond which is not being assigned and transferred by the initial registered owner, in any denomination or denominations in any integral multiple of $5,000 (subject to the requirement hereinafter stated that each substitute bond issued in exchange for any portion of this Bond shall have a single stated principal maturity date), upon surrender of this Bond to the Paying Agent/Registrar for cancellation, all in accordance with the form and procedures set forth in the Bond Resolution. If this Bond or any portion hereof is assigned and transferred or converted each bond issued in exchange for any portion hereof shall have a single stated principal maturity date corresponding to the due date of the installment of principal of this Bond or portion hereof for which the substitute bond is being exchanged, and shall bear interest at the rate applicable to and borne by such installment of principal or portion thereof. Such bonds, respectively, shall be subject to redemption prior to maturity on the same dates and for the same prices as the corresponding installment of principal of this Bond or portion hereof for which they are being exchanged. No such bond shall be payable in installments, but shall have only one stated principal maturity date. AS PROVIDED IN THE BOND RESOLUTION, THIS BOND IN ITS PRESENT FORM MAY BE ASSIGNED AND TRANSFERRED OR CONVERTED ONCE ONLY, and to one or more assignees, but the bonds issued and delivered in exchange for this Bond or any portion hereof may be assigned and transferred, and converted, subsequently, as provided in the Bond Resolution. The Issuer shall pay the Paying Agent/Registrar's standard or customary fees and charges for transferring, converting, and exchanging this Bond or any portion thereof, but the one requesting such transfer, conversion, and exchange shall pay any taxes or governmental charges required to be paid with respect thereto. The Paying Agent/Registrar shall not be required to make any such assignment, conversion, or exchange (i) during the period commencing with the close of business on any Record Date and ending with the opening of business on the next following principal or interest payment date, or, (ii) with respect to any Bond or portion thereof called for prepayment or redemption prior to maturity, within 45 days prior to its prepayment or redemption date.

IN THE EVENT any Paying Agent/Registrar for this Bond is changed by the Issuer, resigns, or otherwise ceases to act as such, the Issuer has covenanted in the Bond Resolution that it promptly will appoint a competent and legally qualified substitute therefor, and promptly will cause written notice thereof to be mailed to the registered owner of this Bond.

IT IS HEREBY certified, recited, and covenanted that this Bond has been duly and validly authorized, issued, and delivered; that all acts, conditions, and things required or proper to be performed, exist, and be done precedent to or in the authorization, issuance, and delivery of this Bond have been performed, existed, and been done in accordance with law; that this Bond and the interest thereon are special obligations of the Issuer which, together with other outstanding parity revenue bonds of the Issuer, are payable from and secured by a first lien on and pledge of the "Gross Revenues", as defined in the Bond Resolution, consisting of payments received by the Issuer from the City, designated as "Dallas Bond Payments", pursuant to a Water Transmission Facilities Financing Agreement, dated November 16, 2010 (the "Contract"), between the Issuer and the City with respect to the acquisition, construction, and financing of an integrated pipeline designated as the "Project" in the Contract. It is specifically provided in the Contract that the City is obligated to make payments in amounts sufficient to pay the principal of and interest on this Bond, when due, and that such payments will be made solely from the gross revenues of the City's combined waterworks and sewer system.

THE ISSUER IS OBLIGATED TO PAY THE PRINCIPAL OF AND INTEREST ON THIS BOND SOLELY FROM AND TO THE EXTENT OF THE GROSS REVENUES DERIVED

FROM THE DALLAS BOND PAYMENTS TO BE RECEIVED FROM THE CITY. NO OTHER ENTITY, INCLUDING THE STATE OF TEXAS, ANY POLITICAL SUBDIVISION THEREOF (OTHER THAN THE CITY), OR ANY OTHER PUBLIC OR PRIVATE BODY, IS OBLIGATED, DIRECTLY, INDIRECTLY, CONTINGENTLY, OR IN ANY OTHER MANNER, TO PAY SUCH PRINCIPAL OR INTEREST FROM ANY OTHER SOURCE WHATSOEVER. THE OWNER OF THIS BOND SHALL NEVER HAVE THE RIGHT TO DEMAND PAYMENT OF THIS BOND OUT OF ANY FUNDS RAISED OR TO BE RAISED BY TAXATION (INCLUDING SPECIFICALLY TAXES RAISED OR TO BE RAISED BY THE CITY) OR FROM ANY OTHER FUNDS OF THE ISSUER EXCEPT THE GROSS REVENUES PLEDGED TO THE PAYMENT OF THIS BOND. NO REPRESENTATION IS MADE HEREIN WITH RESPECT TO THE ANTICIPATED SUFFICIENCY OF THE GROSS REVENUES PLEDGED TO THE PAYMENT OF THIS BOND. NO PART OF THE PHYSICAL PROPERTY OF THE CITY IS ENCUMBERED BY ANY LIEN OR SECURITY INTEREST FOR THE BENEFIT OF THE OWNERS OF THIS BOND.

THE ISSUER has reserved the right, subject to the restrictions stated in the Bond Resolution, to issue Additional Bonds payable from and secured by a first lien on and pledge of the Gross Revenues on a parity with this Bond.

THE ISSUER also has reserved the right to amend the Bond Resolution, with the approval of the owners of 51% of the outstanding bonds secured by a first lien on the Gross Revenues, subject to the restrictions stated in the Bond Resolution.

THE REGISTERED OWNER hereof shall never have the right to demand payment of this Bond or the interest hereon from any source whatsoever other than specified in the Contract and the Bond Resolution.

BY BECOMING the registered owner of this Bond, the registered owner thereby acknowledges all of the terms and provisions of the Bond Resolution, agrees to be bound by such terms and provisions, acknowledges that the Bond Resolution is duly recorded and available for inspection in the official minutes and records of the governing body of the Issuer, and agrees that the terms and provisions of this Bond and the Bond Resolution constitute a contract between the registered owner hereof and the Issuer.

IN WITNESS WHEREOF, the Issuer has caused this Bond to be signed with the manual or facsimile signature of the President of the Board of Directors of the Issuer and countersigned with the manual or facsimile signature of the Secretary of the Board of Directors of the Issuer, has caused the official seal of the Issuer to be duly impressed, or placed in facsimile, on this Bond, and has caused this Bond to be dated as of _____, ____*.

_____ _____

Secretary, Board of Directors President, Board of Directors

(DISTRICT SEAL)

*From Approval Certificate.

FORM OF REGISTRATION CERTIFICATE OF THE
COMPTROLLER OF PUBLIC ACCOUNTS:

COMPTROLLER'S REGISTRATION CERTIFICATE: REGISTER NO.

I hereby certify that this Bond has been examined, certified as to validity, and approved by the Attorney General of the State of Texas, and that this Bond has been registered by the Comptroller of Public Accounts of the State of Texas.

Witness my signature and seal this

_____
Comptroller of Public Accounts of the State of Texas

(COMPTROLLER'S SEAL)

Section 6. CHARACTERISTICS OF THE SERIES 2014 BONDS. (a) Registration, Transfer, Conversion and Exchange; Authentication. The Issuer shall keep or cause to be kept at the principal corporate trust office of BOKF, NA dba Bank of Texas, Dallas, Texas (the "Paying Agent/Registrar") books or records for the registration of the transfer, conversion and exchange of the Series 2014 Bonds (the "Registration Books"), and the Issuer hereby appoints the Paying Agent/Registrar as its registrar and transfer agent to keep such books or records and make such registrations of transfers, conversions and exchanges under such reasonable regulations as the Issuer and Paying Agent/Registrar may prescribe; and the Paying Agent/Registrar shall make such registrations, transfers, conversions and exchanges as herein provided. The Paying Agent/Registrar shall obtain and record in the Registration Books the address of the registered owner of each Series 2014 Bond to which payments with respect to the Series 2014 Bonds shall be mailed, as herein provided; but it shall be the duty of each registered owner to notify the Paying Agent/Registrar in writing of the address to which payments shall be mailed, and such interest payments shall not be mailed unless such notice has been given. To the extent possible and under reasonable circumstances, all transfers of Series 2014 Bonds shall be made within three Business Days after request and presentation thereof. The Issuer shall have the right to inspect the Registration Books during regular business hours of the Paying Agent/Registrar, but otherwise the Paying Agent/Registrar shall keep the Registration Books confidential and, unless otherwise required by law, shall not permit their inspection by any other entity. The Paying Agent/Registrar's standard or customary fees and charges for making such registration, transfer, conversion, exchange and delivery of a substitute Series 2014 Bond or Series 2014 Bonds shall be paid as provided in the FORM OF BOND set forth in this Resolution. Registration of assignments, transfers, conversions and exchanges of Series 2014 Bonds shall be made in the manner provided and with the effect stated in the FORM OF BOND set forth in this Resolution. Each substitute Bond shall bear a letter and/or number to distinguish it from each other Bond.

An authorized representative of the Paying Agent/Registrar shall, before the delivery of any such Bond, date and manually sign the Paying Agent/Registrar's Authentication Certificate, and no such Bond shall be deemed to be issued or outstanding unless such Certificate is so executed. The Paying Agent/Registrar promptly shall cancel all paid Series 2014 Bonds surrendered for conversion and exchange. No additional ordinances, orders, or resolutions need be passed or adopted by the

governing body of the Issuer or any other body or person so as to accomplish the foregoing conversion and exchange of any Bond or portion thereof, and the Paying Agent/Registrar shall provide for the printing, execution, and delivery of the substitute Series 2014 Bonds in the manner prescribed herein, and said Series 2014 Bonds shall be of type composition printed on paper with lithographed or steel engraved borders of customary weight and strength. Pursuant to Subchapter D, Chapter 1201, Texas Government Code, the duty of conversion and exchange of Series 2014 Bonds as aforesaid is hereby imposed upon the Paying Agent/Registrar, and, upon the execution of said Certificate, the converted and exchanged Series 2014 Bond shall be valid, incontestable, and enforceable in the same manner and with the same effect as the Series 2014 Bonds which initially were issued and delivered pursuant to this Resolution, approved by the Attorney General, and registered by the Comptroller of Public Accounts.

(b) Payment of Series 2014 Bonds and Interest. The Issuer hereby further appoints the Paying Agent/Registrar to act as the paying agent for paying the principal of and interest on the Series 2014 Bonds, all as provided in this Resolution. The Paying Agent/Registrar shall keep proper records of all payments made by the Issuer and the Paying Agent/Registrar with respect to the Series 2014 Bonds.

(c) In General. The Series 2014 Bonds (i) shall be issued in fully registered form, without interest coupons, with the principal of and interest on such Series 2014 Bonds to be payable only to the registered owners thereof, (ii) may be redeemed prior to their scheduled maturities, (iii) may be transferred and assigned, (iv) may be converted and exchanged for other Series 2014 Bonds, (v) shall have the characteristics, (vi) shall be signed, sealed, executed and authenticated, (vii) shall be payable as to principal and interest, and (viii) shall be administered and the Paying Agent/Registrar and the Issuer shall have certain duties and responsibilities with respect to the Series 2014 Bonds, all as provided, and in the manner and to the effect as required or indicated, in the FORM OF Series 2014 Bond set forth in this Resolution. The Series 2014 Bonds initially issued and delivered pursuant to this Resolution are not required to be, and shall not be, authenticated by the Paying Agent/Registrar, but on each substitute Series 2014 Bond issued in conversion of and exchange for any Series 2014 Bond or Series 2014 Bonds issued under this Resolution the Paying Agent/Registrar shall execute the PAYING AGENT/REGISTRAR'S AUTHENTICATION CERTIFICATE, in the form set forth in the FORM OF SERIES 2014 SUBSTITUTE BOND.

(d) Substitute Paying Agent/Registrar. The Issuer covenants with the registered owners of the Series 2014 Bonds that at all times while the Series 2014 Bonds are outstanding the Issuer will provide a competent and legally qualified bank, trust company, financial institution, or other agency to act as and perform the services of Paying Agent/Registrar for the Series 2014 Bonds under this Resolution, and that the Paying Agent/Registrar will be one entity. The Issuer reserves the right to, and may, at its option, change the Paying Agent/Registrar upon not less than 120 days written notice to the Paying Agent/Registrar, to be effective not later than 60 days prior to the next principal or interest payment date after such notice. In the event that the entity at any time acting as Paying Agent/Registrar (or its successor by merger, acquisition, or other method) should resign or otherwise cease to act as such, the Issuer covenants that promptly it will appoint a competent and legally qualified bank, trust company, financial institution, or other agency to act as Paying Agent/Registrar under this Resolution. Upon any change in the Paying Agent/Registrar, the previous Paying Agent/Registrar promptly shall transfer and deliver the Registration Books (or a copy thereof), along with all other pertinent books and records relating to the Series 2014 Bonds, to the new Paying

Agent/Registrar designated and appointed by the Issuer. Upon any change in the Paying Agent/Registrar, the Issuer promptly will cause a written notice thereof to be sent by the new Paying Agent/Registrar to each registered owner of the Series 2014 Bonds, by United States mail, first-class postage prepaid, which notice also shall give the address of the new Paying Agent/Registrar. By accepting the position and performing as such, each Paying Agent/Registrar shall be deemed to have agreed to the provisions of this Resolution, and a certified copy of this Resolution shall be delivered to each Paying Agent/Registrar.

(e) Reporting Requirements of Paying Agent/Registrar. To the extent required by the Internal Revenue Code of 1985 (the "Code") and the regulations promulgated and pertaining thereto, it shall be the duty of the Paying Agent/Registrar, on behalf of the Issuer, to report to the owners of the Series 2014 Bonds and the Internal Revenue Service (i) the amount of "reportable payments", if any, subject to backup withholding during each year and the amount of tax withheld, if any, with respect to payments of the Series 2014 Bonds and (ii) the amount of interest or amount treating as interest on the Series 2014 Bonds and required to be included in gross income of the owner thereof.

(f) Book-Entry Only System. The Series 2014 Bonds issued in exchange for the Series 2014 Bonds initially issued to the purchaser specified herein shall be initially issued in the form of a separate single fully registered Series 2014 Bond for each of the maturities thereof. Upon initial issuance, the ownership of each such Series 2014 Bond shall be registered in the name of Cede & Co., as nominee of Depository Trust Company of New York ("DTC"), and except as provided in subsection (f) hereof, all of the outstanding Series 2014 Bonds shall be registered in the name of Cede & Co., as nominee of DTC.

With respect to Series 2014 Bonds registered in the name of Cede & Co., as nominee of DTC, the Issuer and the Paying Agent/Registrar shall have no responsibility or obligation to any DTC Participant or to any person on behalf of whom such a DTC Participant holds an interest on the Series 2014 Bonds. Without limiting the immediately preceding sentence, the Issuer and the Paying Agent/Registrar shall have no responsibility or obligation with respect to (i) the accuracy of the records of DTC, Cede & Co. or any DTC Participant with respect to any ownership interest in the Series 2014 Bonds, (ii) the delivery to any DTC Participant or any other person, other than a Bondholder, as shown on the Registration Books, of any notice with respect to the Series 2014 Bonds, including any notice of redemption, or (iii) the payment to any DTC Participant or any other person, other than a Bondholder, as shown in the Registration Books of any amount with respect to principal of, premium, if any, or interest on, as the case may be, the Series 2014 Bonds. Notwithstanding any other provision of this Resolution to the contrary, the Issuer and the Paying Agent/Registrar shall be entitled to treat and consider the person in whose name each Series 2014 Bond is registered in the Registration Books as the absolute owner of such Series 2014 Bond for the purpose of payment of principal, premium, if any, and interest, as the case may be, with respect to such Bond, for the purpose of giving notices of redemption and other matters with respect to such Bond, for the purpose of registering transfers with respect to such Bond, and for all other purposes whatsoever. The Paying Agent/Registrar shall pay all principal of, premium, if any, and interest on the Series 2014 Bonds only to or upon the order of the respective owners, as shown in the Registration Books as provided in this Resolution, or their respective attorneys duly authorized in writing, and all such payments shall be valid and effective to fully satisfy and discharge the Issuer's obligations with respect to payment of principal of, premium, if any, and interest on, or as the case may be, the Series 2014 Bonds to the extent of the sum or sums so paid. No person other than an

owner, as shown in the Registration Books, shall receive a Series 2014 Bond certificate evidencing the obligation of the Issuer to make payments of principal, premium, if any, and interest, as the case may be, pursuant to this Resolution. Upon delivery by DTC to the Paying Agent/Registrar of written notice to the effect that DTC has determined to substitute a new nominee in place of Cede & Co., and subject to the provisions in this Resolution with respect to interest checks being mailed to the registered owner at the close of business on the Record Date, the word "Cede & Co." in this Resolution shall refer to such new nominee of DTC. The Issuer has executed and delivered to DTC a "Blanket Letter of Representation" to effect the use of a book-entry-only system for obligations such as the Series 2014 Bonds.

(g) Successor Securities Depository; Transfers Outside Book-Entry Only System. In the event that the Issuer or the Paying Agent/Registrar determines that DTC is incapable of discharging its responsibilities described herein and in the Blanket Letter of Representation of the Issuer to DTC and that it is in the best interest of the beneficial owners of the Series 2014 Bonds that they be able to obtain certificated Series 2014 Bonds, the Issuer or the Paying Agent/Registrar shall (i) appoint a successor securities depository, qualified to act as such under Section 17(a) of the Securities and Exchange Act of 1934, as amended, notify DTC and DTC Participants of the appointment of such successor securities depository and transfer one or more separate Series 2014 Bonds to such successor securities depository or (ii) notify DTC and DTC Participants of the availability through DTC of Series 2014 Bonds and transfer one or more separate Series 2014 Bonds to DTC Participants having Series 2014 Bonds credited to their DTC accounts. In such event, the Series 2014 Bonds shall no longer be restricted to being registered in the Registration Books in the name of Cede & Co., as nominee of DTC, but may be registered in the name of the successor securities depository, or its nominee, or in whatever name or names Bondholders transferring or exchanging Series 2014 Bonds shall designate, in accordance with the provisions of this Resolution.

(h) Payments to Cede & Co. Notwithstanding any other provision of this Resolution to the contrary, so long as any Bond is registered in the name of Cede & Co., as nominee of DTC, all payments with respect to principal of, premium, if any, and interest on, or as the case may be, such Bond and all notices with respect to such Bond shall be made and given, respectively, in the manner provided in the representation letter of the Issuer to DTC.

Section 7. FORM OF SERIES 2014 SUBSTITUTE BONDS. The form of all Series 2014 Bonds issued in conversion and exchange or replacement of any other Series 2014 Bond or portion thereof, including the form of Paying Agent/Registrar's Certificate to be printed on each of such Series 2014 Bonds, and the Form of Assignment to be printed on each of the Series 2014 Bonds, shall be, respectively, substantially as follows, with such appropriate variations, omissions, or insertions as are permitted or required by this Resolution.

FORM OF SERIES 2014 SUBSTITUTE BOND

NO.____ PRINCIPAL AMOUNT
$_____

UNITED STATES OF AMERICA
STATE OF TEXAS
TARRANT REGIONAL WATER DISTRICT,
A WATER CONTROL AND IMPROVEMENT DISTRICT,
WATER TRANSMISSION FACILITIES CONTRACT REVENUE BOND
(CITY OF DALLAS, TEXAS PROJECT),
SERIES 2014

INTEREST RATE	MATURITY DATE	ISSUE DATE	CUSIP NO.
%	September 1, ____	_____*, 2014	

ON THE MATURITY DATE specified above TARRANT REGIONAL WATER DISTRICT, A WATER CONTROL AND IMPROVEMENT DISTRICT (the "Issuer"), being a political subdivision of the State of Texas, hereby promises to pay to CEDE & CO. or to the registered assignee hereof (either being hereinafter called the "registered owner") the principal amount of _____ DOLLARS and to pay interest thereon, calculated on the basis of a 360-day year composed of twelve 30-day months, from the Issue Date specified above, to the Maturity Date specified above, or the date of redemption prior to maturity, at the interest rate per annum specified above; with interest being payable semiannually on each March 1 and September 1, commencing _____**, except that if the date of authentication of this Bond is later than the first Record Date (hereinafter defined), such principal amount shall bear interest from the interest payment date next preceding the date of authentication, unless such date of authentication is after any Record Date (hereinafter defined) but on or before the next following interest payment date, in which case such principal amount shall bear interest from such next following interest payment date.

THE PRINCIPAL OF AND INTEREST ON this Bond are payable in lawful money of the United States of America, without exchange or collection charges. The principal of this Bond shall be paid to the registered owner hereof upon presentation and surrender of this Bond at maturity or upon the date fixed for its redemption prior to maturity, at the principal corporate trust office of BOKF, NA dba BANK OF TEXAS, Dallas, Texas, which is the "Paying Agent/Registrar" for this Bond. The payment of interest on this Bond shall be made by the Paying Agent/Registrar to the registered owner hereof on each interest payment date by check dated as of such interest payment date, drawn by the Paying Agent/Registrar on, and payable solely from, funds of the Issuer required by the resolution authorizing the issuance of the Bonds (the "Bond Resolution") to be on deposit with the Paying Agent/Registrar for such purpose as hereinafter provided; and such check shall be sent by the Paying Agent/Registrar by United States mail, first-class postage prepaid, on each such interest payment date, to the registered owner hereof, at the address of the registered owner, as it appeared at the close of business on the 15th day of the month next preceding each such date (the

* Date of initial delivery to the Underwriters (as defined in Section 33 hereof).
** From Approval Certificate.

"Record Date") on the Registration Books kept by the Paying Agent/Registrar, as hereinafter described. However, notwithstanding the foregoing provisions, (1) the payment of such interest may be made by any other method acceptable to the Paying Agent/Registrar and requested by, and at the risk and expense of, the registered owner hereof and (2) upon the written request, and at the risk and expense of, the registered owner of any Bond of this Series in the amount of $1,000,000 or more, delivered to the Paying Agent/Registrar not less than 15 days prior to any interest payment date, payment of the interest due on such Bond on such date shall be paid on such date by wire transfer to any designated account in the United States of America which has available to it the wire service facilities of the Federal Reserve Bank. Any accrued interest due upon the redemption of this Bond prior to maturity as provided herein shall be paid to the registered owner at the principal corporate trust office of the Paying Agent/Registrar upon presentation and surrender of this Bond for redemption and payment at the principal corporate trust office of the Paying Agent/Registrar. The Issuer covenants with the registered owner of this Bond that on or before each principal payment date, interest payment date, and accrued interest payment date for this Bond it will make available to the Paying Agent/Registrar, from the "Interest and Redemption Fund" created by the Bond Resolution, the amounts required to provide for the payment, in immediately available funds, of all principal of and interest on the Bonds, when due.

IF THE DATE for the payment of the principal of or interest on this Bond shall be a Saturday, Sunday, a legal holiday, or a day on which banking institutions in the city where the Paying Agent/Registrar is located are authorized by law or executive order to close, then the date for such payment shall be the next succeeding day which is not such a Saturday, Sunday, legal holiday, or day on which banking institutions are authorized to close; and payment on such date shall have the same force and effect as if made on the original date payment was due.

THIS BOND is one of a series of bonds (the "Bonds") dated as of _____*, 2014, authorized in accordance with the Constitution and laws of the State of Texas in the principal amount of $_____* for the purpose of obtaining funds to (i) pay for design, acquisition, and constructions costs related to the Dallas Project Component of the Project, as such terms are defined in the Bond Resolution, consisting generally of a portion of the share of the City of Dallas, Texas (the "City") of the costs of an integrated pipeline to serve the City and the Issuer, (ii) fund a reserve fund for the Bonds, and (iii) pay costs of issuance of the Bonds.

ON _____, ____*, or any date thereafter, the Bonds may be redeemed prior to their scheduled maturities, at the option of the Issuer, with funds derived from any available source, as a whole, or in part, and, if in part, the Issuer shall select and designate the particular maturities and amounts of Bonds to be redeemed, and if less than all of the Bonds of a maturity are to be redeemed, the Issuer shall direct the Paying Agent/Registrar to call by lot or other customary method of random selection the particular Bonds or portions thereof to be redeemed (only in an integral multiple of $5,000), at the redemption price of the principal amount to be redeemed, plus accrued interest to the date fixed for redemption.

** From Approval Certificate.

*[THE BONDS maturing on September 1, ____ and September 1, ____ (the "Term Bonds") are subject to mandatory redemption prior to maturity in part, by lot or other customary random method selected by the Paying Agent/Registrar, at a redemption price equal to the principal amount of the Term Bonds or portions thereof to be redeemed plus accrued interest to the redemption date, on September 1 in each of the years and in the principal amounts as follows:

Term Bonds maturing on September 1, ____

Years	Amounts

Term Bonds maturing on September 1, ____

Years	Amounts

The principal amount of the Term Bonds of a maturity required to be redeemed pursuant to the operation of such mandatory redemption provisions shall be reduced, at the option of the Issuer, by the principal amount of the Term Bonds of such maturity which, at least 50 days prior to the mandatory redemption date (1) shall have been acquired by the Issuer at a price not exceeding the principal amount of such Term Bonds plus accrued interest to the date of purchase thereof, and delivered to the Paying Agent/Registrar for cancellation, (2) shall have been purchased and canceled by the Paying Agent/Registrar at the request of the Issuer at a price not exceeding the principal amount of such Term Bonds plus accrued interest to the date of purchase, or (3) shall have been redeemed pursuant to the optional redemption provisions and not theretofore credited against a mandatory redemption requirement.]

DURING ANY PERIOD in which ownership of the Bonds is determined by a book entry at a securities depository for the Bonds, if fewer than all of the Bonds of the same maturity and bearing the same interest rate are to be redeemed, the particular Bonds of such maturity and bearing such interest rate shall be selected in accordance with the arrangements between the Issuer and the securities depository.

AT LEAST 30 days prior to the date fixed for any redemption of Bonds or portions thereof prior to maturity at the option of the Issuer, a written notice of such redemption shall be sent by the Paying Agent/Registrar by United States mail, first-class postage prepaid, to the registered owner appearing on the Registration Books at the close of business on the day next preceding the date of mailing of such notice; provided, however, that any notice so mailed shall be conclusively presumed

* From Approval Certificate, if applicable.

to have been duly given and the failure to receive such notice, or any defect therein shall not affect the validity or effectiveness of the proceedings for the redemption of any Bond at the option of the Issuer. By the date fixed for any such redemption due provision shall be made with the Paying Agent/Registrar for the payment of the required redemption price for the Bonds or portions thereof which are to be so redeemed, plus accrued interest thereon to the date fixed for redemption. If such written notice of redemption is mailed and if due provision for such payment is made, all as provided above, the Bonds or portions thereof which are to be so redeemed thereby automatically shall be treated as redeemed prior to their scheduled maturities, and they shall not bear interest after the date fixed for redemption, and they shall not be regarded as being outstanding except for the right of the registered owner to receive the redemption price plus accrued interest from the Paying Agent/Registrar out of the funds provided for such payment. If a portion of any Bond shall be redeemed a substitute Bond or Bonds having the same maturity date, bearing interest at the same rate, in any denomination or denominations in any integral multiple of $5,000, at the written request of the registered owner, and in aggregate principal amount equal to the unredeemed portion thereof, will be issued to the registered owner upon the surrender thereof for cancellation, at the expense of the Issuer, all as provided in the Bond Resolution.

THIS BOND OR ANY PORTION OR PORTIONS HEREOF IN ANY INTEGRAL MULTIPLE OF $5,000 may be assigned and shall be transferred only in the Registration Books of the Issuer kept by the Paying Agent/Registrar acting in the capacity of registrar for the Bonds, upon the terms and conditions set forth in the Bond Resolution. Among other requirements for such assignment and transfer, this Bond must be presented and surrendered to the Paying Agent/Registrar, together with proper instruments of assignment, in form and with guarantee of signatures satisfactory to the Paying Agent/Registrar, evidencing assignment of this Bond or any portion or portions hereof in any integral multiple of $5,000 to the assignee or assignees in whose name or names this Bond or any such portion or portions hereof is or are to be transferred and registered. The form of Assignment printed or endorsed on this Bond shall be executed by the registered owner or its duly authorized attorney or representative, to evidence the assignment hereof. A new Bond or Bonds payable to such assignee or assignees (which then will be the new registered owner or owners of such new Bond or Bonds), or to the previous registered owner in the case of the assignment and transfer of only a portion of this Bond, may be delivered by the Paying Agent/Registrar in conversion of and exchange for this Bond, all in the form and manner as provided in the next paragraph hereof for the conversion and exchange of other bonds. The Issuer shall pay the Paying Agent/Registrar's standard or customary fees and charges for making such transfer, but the one requesting such transfer shall pay any taxes or other governmental charges required to be paid with respect thereto. The Paying Agent/Registrar shall not be required to make transfers of registration of this Bond or any portion hereof (i) during the period commencing with the close of business on any Record Date and ending with the opening of business on the next following principal or interest payment date, or, (ii) with respect to any Bond or any portion thereof called for redemption prior to maturity, within 45 days prior to its redemption date. The registered owner of this Bond shall be deemed and treated by the Issuer and the Paying Agent/Registrar as the absolute owner hereof for all purposes, including payment and discharge of liability upon this Bond to the extent of such payment, and the Issuer and the Paying Agent/Registrar shall not be affected by any notice to the contrary.

ALL BONDS OF THIS SERIES are issuable solely as fully registered bonds, without interest coupons, in the denomination of any integral multiple of $5,000. As provided in the Bond Resolution, this Bond, or any unredeemed portion hereof, may, at the request of the registered owner or the assignee or assignees hereof, be converted into and exchanged for a like aggregate principal amount of fully registered bonds, without interest coupons, payable to the appropriate registered owner, assignee, or assignees, as the case may be, having the same maturity date, and bearing interest at the same rate, in any denomination or denominations in any integral multiple of $5,000 as requested in writing by the appropriate registered owner, assignee, or assignees, as the case may be, upon surrender of this Bond to the Paying Agent/Registrar for cancellation, all in accordance with the form and procedures set forth in the Bond Resolution. The Issuer shall pay the Paying Agent/Registrar's standard or customary fees and charges for transferring, converting, and exchanging any Bond or any portion thereof, but the one requesting such transfer, conversion, and exchange shall pay any taxes or governmental charges required to be paid with respect thereto as a condition precedent to the exercise of such privilege of conversion and exchange. The Paying Agent/Registrar shall not be required to make any such conversion and exchange (i) during the period commencing with the close of business on any Record Date and ending with the opening of business on the next following principal or interest payment date, or, (ii) with respect to any Bond or portion thereof called for redemption prior to maturity, within 45 days prior to its redemption date.

IN THE EVENT any Paying Agent/Registrar for this Bond is changed by the Issuer, resigns, or otherwise ceases to act as such, the Issuer has covenanted in the Bond Resolution that it promptly will appoint a competent and legally qualified substitute therefor, and promptly will cause written notice thereof to be mailed to the registered owners of this Bond.

IT IS HEREBY certified, recited, and covenanted that this Bond has been duly and validly authorized, issued, and delivered; that all acts, conditions, and things required or proper to be performed, exist, and be done precedent to or in the authorization, issuance, and delivery of this Bond have been performed, existed, and been done in accordance with law; that this Bond and the interest thereon are special obligations of the Issuer, which, together with other outstanding parity revenue bonds of the Issuer, are payable from and secured by a first lien on and pledge of the "Gross Revenues", as defined in the Bond Resolution, consisting of payments received by the Issuer from the City designated as "Dallas Bond Payments", pursuant to a Water Transmission Facilities Financing Agreement, dated November 16, 2010 (the "Contract"), between the Issuer and the City with respect to the acquisition, construction, and financing of an integrated pipeline designated as the "Project" in the Contract. It is specifically provided in the Contract that the City is obligated to make payments in amounts sufficient to pay the principal of and interest on this Bond, when due, and that such payments will be made solely from the gross revenues of the City's combined waterworks and sewer system.

THE ISSUER IS OBLIGATED TO PAY THE PRINCIPAL OF AND INTEREST ON THIS BOND SOLELY FROM AND TO THE EXTENT OF THE GROSS REVENUES DERIVED FROM THE DALLAS BOND PAYMENTS TO BE RECEIVED FROM THE CITY. NO OTHER ENTITY, INCLUDING THE STATE OF TEXAS, ANY POLITICAL SUBDIVISION THEREOF (OTHER THAN THE CITY), OR ANY OTHER PUBLIC OR PRIVATE BODY, IS OBLIGATED, DIRECTLY, INDIRECTLY, CONTINGENTLY, OR IN ANY OTHER MANNER, TO PAY SUCH PRINCIPAL OR INTEREST FROM ANY OTHER SOURCE WHATSOEVER. THE OWNER OF

THIS BOND SHALL NEVER HAVE THE RIGHT TO DEMAND PAYMENT OF THIS BOND OUT OF ANY FUNDS RAISED OR TO BE RAISED BY TAXATION (INCLUDING SPECIFICALLY TAXES RAISED OR TO BE RAISED BY THE CITY) OR FROM ANY OTHER FUNDS OF THE ISSUER EXCEPT THE GROSS REVENUES PLEDGED TO THE PAYMENT OF THIS BOND. NO REPRESENTATION IS MADE HEREIN WITH RESPECT TO THE ANTICIPATED SUFFICIENCY OF THE GROSS REVENUES PLEDGED TO THE PAYMENT OF THIS BOND. NO PART OF THE PHYSICAL PROPERTY OF THE CITY IS ENCUMBERED BY ANY LIEN OR SECURITY INTEREST FOR THE BENEFIT OF THE OWNERS OF THIS BOND.

THE ISSUER has reserved the right, subject to the restrictions stated in the Bond Resolution, to issue Additional Bonds payable from and secured by a first lien on and pledge of the Gross Revenues on a parity with this Bond.

THE ISSUER also has reserved the right to amend the Bond Resolution, with the approval of the owners of 51% of the outstanding bonds secured by a first lien on the Gross Revenues, subject to the restrictions stated in the Bond Resolution.

THE REGISTERED OWNER hereof shall never have the right to demand payment of this Bond or the interest hereon from any source whatsoever other than specified in the Contract and the Bond Resolution.

BY BECOMING the registered owner of this Bond, the registered owner thereby acknowledges all of the terms and provisions of the Bond Resolution, agrees to be bound by such terms and provisions, acknowledges that the Bond Resolution is duly recorded and available for inspection in the official minutes and records of the governing body of the Issuer, and agrees that the terms and provisions of this Bond and the Bond Resolution constitute a contract between each registered owner hereof and the Issuer.

IN WITNESS WHEREOF, the Issuer has caused this Bond to be signed with the facsimile signature of the President of the Board of Directors of the Issuer and countersigned with the facsimile signature of the Secretary of the Board of Directors of the Issuer, and has caused the official seal of the Issuer to be duly impressed, or placed in facsimile, on this Bond.

XXXXX	XXXXX
Secretary, Board of Directors	President, Board of Directors

(DISTRICT SEAL)

FORM OF PAYING AGENT/REGISTRAR'S AUTHENTICATION CERTIFICATE

PAYING AGENT/REGISTRAR'S AUTHENTICATION CERTIFICATE

(To be executed if this Bond is not accompanied by an executed Registration Certificate of the Comptroller of Public Accounts of the State of Texas)

It is hereby certified that this Bond has been issued under the provisions of the Bond Resolution described in the text of this Bond; and that this Bond has been issued in conversion or replacement of, or in exchange for, a bond, bonds, or a portion of a bond or bonds of a series which originally was approved by the Attorney General of the State of Texas and registered by the Comptroller of Public Accounts of the State of Texas.

Dated

BOKF, NA dba BANK OF TEXAS,
Dallas, Texas

By _____
Authorized Representative

FORM OF ASSIGNMENT:

ASSIGNMENT

FOR VALUE RECEIVED, the undersigned sells, assigns and transfers unto

Please Insert Social Security or
Other Identifying Number of Assignee

/_____/

_____

(Name and Address of Assignee)

the within Bond and does hereby irrevocably constitute and appoint _____ to transfer said Bond on the books kept for registration thereof with full power of substitution in the premises.

Date: _____

_____

Signature Guaranteed: _____

NOTICE: The signature to this assignment must correspond with the name as it appears upon the face of the within Bond in every particular, without alteration or enlargement or any change whatever; and

NOTICE: Signature(s) must be guaranteed by an eligible guarantor institution participating in a Securities Transfer Association recognized signature guarantee program.

Section 8. ADDITIONAL DEFINITIONS. In addition to the definitions heretofore provided for, the following terms as used in this Resolution shall have the meanings set forth below, unless the text hereof specifically indicates otherwise:

The term "Additional Bonds" shall mean the additional parity revenue bonds permitted to be authorized in the future on a parity with the Bonds, as hereinafter provided in Section 19 hereof.

The term "Board" shall mean the Board of Directors of the District, being the governing body of the District, and it is further resolved that the declarations and covenants of the District contained in this Resolution are made by, and for and on behalf of the Board and the District, and are binding upon the Board and the District for all purposes.

The terms "Bond Resolution" and "Resolution" shall mean this resolution authorizing the Series 2014 Bonds.

The term "Bonds" shall mean (i) the unpaid and unrefunded Series 2012 Bonds to be outstanding after the delivery of the Series 2014 Bonds, (ii) the Series 2014 Bonds, and (ii) any Additional Bonds.

The term "Business Day" shall mean a day other than a Saturday, a Sunday, a legal holiday, or a day on which banking institutions are authorized by law or executive order to close in the City or the city where the principal corporate trust office of the Paying Agent/Registrar is located.

The term "City" shall mean the City of Dallas, Texas.

The term "Contract" shall mean the "Water Transmission Facilities Financing Agreement," dated November 16, 2010, between the Issuer and the City.

The term "Credit Facility" shall mean (i) a policy of insurance or a surety bond, issued by an issuer of policies of insurance insuring the timely payment of debt service on governmental obligations, provided that a nationally recognized rating agency having an outstanding rating on outstanding Bonds would rate the Bonds fully insured by a standard policy issued by the issuer on the date the policy of insurance or surety bond is issued in its two highest generic rating categories for such obligations; and (ii) a letter or line of credit issued by any financial institution, provided that a rating agency having an outstanding rating on the Bonds would rate the Bonds in its two highest generic rating categories for such Bonds on the date such letter of line of credit is issued if the letter or line of credit proposed to be issued by such financial institution secured the timely payment of the entire principal amount of the Bonds and the interest thereon.

The term "Dallas Bond Payments" shall mean the payments received by the Issuer from the City pursuant to Contract and designated in the Contract as "Dallas Bond Payments."

The term "Dallas Project Component" shall have the same meaning given such term in the Contract.

The term "Gross Revenues" shall mean the Dallas Bond Payments received by the Issuer from the City pursuant to the Contract, together with any interest earnings thereon.

The terms "Issuer" and "District" shall mean Tarrant Regional Water District, a Water Control and Improvement District.

The term "Project" shall mean the integrated pipeline designated as the "Project" in the Contract.

The term "Series 2012 Bond Resolution" shall mean the resolution authorizing the issuance of the Series 2012 Bonds.

The term "Series 2012 Bonds" shall mean all unpaid and unrefunded "Tarrant Regional Water District, a Water Control and Improvement District, Water Transmission Facilities Contract Revenue Bonds (City of Dallas Project), Series 2012.

The term "Series 2014 Bonds" shall mean collectively the Initial Bond as described and defined in Sections 1, 2, and 3 of this Bond Resolution, and all substitute bonds exchanged therefor, as well as all other substitute bonds and replacement bonds issued pursuant to this Resolution, all as provided for herein.

The terms "year" and "fiscal year" shall mean the District's fiscal year, which initially shall be the twelve month period ending on September 30, but which subsequently may be any other 12 month period hereafter established by the District as a fiscal year for the purposes of the Contract and any resolution authorizing the Bonds.

Section 9. PLEDGE. (a) The Series 2014 Bonds and the interest thereon, are and shall be secured equally and ratably, on a parity, by and payable from a first lien on and pledge of the Gross Revenues; and the Series 2014 Bonds are Additional Bonds payable from and secured by, on a parity with all outstanding Bonds, a first lien on and pledge of the Gross Revenues, as permitted by Section 19 of the Series 2012 Bond Resolution.

(b) It is specifically recognized that the City is required to make Dallas Bond Payments from the gross revenues of its combined waterworks and sewer system, to the Issuer pursuant to the Contract sufficient to enable the Issuer to make all deposits and payments provided for herein, and that the Bonds, and the interest thereon, are and shall be payable from and secured by a first lien on and pledge of all of the Gross Revenues, and said Gross Revenues are further pledged irrevocably to the establishment and maintenance of the Funds hereinafter created.

(c) Chapter 1208, Government Code, applies to the issuance of the Bonds and the pledge of the Gross Revenues granted by the Issuer under this Section, and is therefore valid, effective, and perfected. Should Texas law be amended at any time while the Bonds are outstanding and unpaid, the result of such amendment being that the pledge of the revenues granted by the Issuer under this Section is to be subject to the filing requirements of Chapter 9, Business & Commerce Code, in order to preserve to the registered owners of the Bonds a security interest in said pledge, the Issuer agrees to take such measures as it determines are reasonable and necessary under Texas law to comply with the applicable provisions of Chapter 9, Business & Commerce Code and enable a filing of a security interest in said pledge to occur.

Section 10. SPECIAL FUNDS. All Gross Revenues shall be accounted for separate and apart from all other funds of the Issuer, and the following special Funds created and established by the Series 2012 Bond Resolution are hereby confirmed and shall be and maintained on the books of the Issuer, so long as any of the Bonds, or interest thereon, are outstanding and unpaid:

(a) the Revenue Fund;

(b) the Interest and Redemption Fund; and

(c) the Reserve Fund.

Section 11. REVENUE FUND. All Gross Revenues shall be credited as received by the Issuer to the Revenue Fund, and shall be deposited from the Revenue Fund into the Interest and Redemption Fund and the Reserve Fund in the manner and amounts hereinafter provided.

Section 12. INTEREST AND REDEMPTION FUND. (a) There shall be deposited into the Interest and Redemption Fund the following:

(i) immediately after the delivery of the Bonds all accrued interest, if any, from the proceeds from the sale of the Bonds;

(ii) on or before each interest payment date on the Bonds, an amount sufficient, together with other amounts, if any, on hand therein, to pay the interest coming due on the Bonds on each such interest payment date;

(iii) on or before each principal payment date on the Bonds, an amount sufficient, together with other amounts, if any, on hand therein, to pay the principal coming due on the Bonds on each such principal payment date; and

(iv) on or before each redemption date for the Bonds, an amount sufficient, together with other amounts, if any, on hand therein, to pay the redemption price, including interest accrued, on Bonds called for redemption on such redemption date.

(b) The Interest and Redemption Fund shall be used solely to pay the principal of and interest on the Bonds when due, whether upon scheduled payment dates or upon earlier redemption.

Section 13. RESERVE FUND. Subject to the provisions of Section 28 of this Resolution, the Issuer shall maintain in the Reserve Fund an amount not less in market value than the average annual principal and interest requirements on all Bonds outstanding (the "Required Reserve") as of the date of any computation thereof. Immediately after the delivery of the Initial Bond, the Issuer shall cause to be deposited from the proceeds from the sale and delivery of the Initial Bond into the Reserve Fund an amount sufficient to cause the Reserve Fund to have on deposit an amount equal to the Required Reserve.

The Reserve Fund shall be used to pay the principal of or interest on the Bonds, at any time when there is not sufficient money available in the Interest and Redemption Fund for such purpose, or to pay the principal of or interest on the last maturing Bonds.

For the purpose of determining the amount on deposit to the credit of the Reserve Fund investments in which money in such account shall have been invested shall be computed at the market value of such investment. The amount on deposit to the credit of the Reserve Fund shall be computed by the Issuer at least annually, and shall be computed immediately upon any withdrawal from the Reserve Fund. The Issuer may at any time substitute a Credit Facility for all or part of the cash or other Credit Facility on deposit in, or held for the benefit of, the Reserve Fund. The amount of a Credit Facility shall be the remaining amount or remaining coverage amount thereof.

When and so long as the money and investments and/or coverage afforded by a Credit Facility in the Reserve Fund total not less than the Required Reserve, no deposits need be made to the credit of the Reserve Fund; but when and if the Reserve Fund at any time contains less than the Required Reserve, the Issuer covenants and agrees to require the City to cure the deficiency in the Required Reserve pursuant to the Contract within twelve (12) months from the date the deficiency in funds occurred. So long as the Reserve Fund contains the Required Reserve in market value, all amounts in excess of Required Reserve, if any, shall, at least annually, on or before the 25th day of August of each year, be deposited to the credit of the Interest and Redemption Fund.

Section 14. PROJECT CONSTRUCTION FUND. There shall be established a Project Construction Fund with the Issuer's depository bank and upon the delivery of each series of Bonds, the net proceeds of such Bonds, after making any required deposits to the Interest and Redemption Fund and the Reserve Fund for such Bonds, shall be deposited into the Project Construction Fund. Money in the Project Construction Fund shall be subject to disbursements by the Issuer for payment of all costs incurred in carrying out the purposes for which the Bonds are issued.

Section 15. INVESTMENTS. Money in any Fund maintained pursuant to this Resolution or any resolution authorizing Additional Bonds may, at the option of the Issuer, be invested in any or all of the authorized investments described in the Public Funds Investment Act, Chapter 2256, Texas Government Code (or any successor statute), in which the Issuer may purchase, sell and invest its funds and funds under its control. Such deposits and investments shall be made consistent with the estimated requirements of such Funds, and any obligation in which money is so invested shall be kept and held at the bank at which the Fund is maintained for the benefit of the owners of the Bonds, and shall be promptly sold and the proceeds of sale applied to the making of all payments required to be made from the Fund from which the investment was made. All earnings from the deposit or investment of any such Fund shall be credited to such Fund. All investment earnings on deposit in the Interest and Redemption Fund shall reduce the amounts which otherwise would be required to be deposited therein, with the result that the City's principal and/or interest payments under the Contract shall be reduced accordingly.

Section 16. DEFICIENCIES OR SURPLUSES IN FUNDS. (a) If the Issuer should fail at any time to deposit into the Interest and Redemption Fund and the Reserve Fund created by this Resolution or any resolution authorizing Additional Bonds the full amounts required, amounts equivalent to such deficiencies shall be set apart and paid into said Funds from the first available Gross Revenues, and such payments shall be in addition to the amounts otherwise required to be deposited into said Funds.

(b) Subject to making the required deposits to the Interest and Redemption Fund and the Reserve Fund when and as required by this Resolution, excess Gross Revenues may be used by the Issuer for any lawful purpose related to the Dallas Project Component of the Project.

Section 17. ISSUER'S EXPENSES. The Gross Revenues in excess of those necessary to establish and maintain the Funds as required in this Resolution, or as hereafter may be required in connection with the issuance of Additional Bonds, shall be used by the Issuer to pay its expenses attributable to the Bonds and the Project, including the fees and charges of the Paying Agent/Registrar, all to the extent provided in the Contract.

Section 18. SECURITY FOR FUNDS. All Funds created by this Resolution or any resolution authorizing Additional Bonds shall be secured in the manner prescribed by law, including particularly, the Public Funds Collateral Act, Chapter 2257, Texas Government Code, for the security of public funds, and such Funds shall be used only for the purposes and in the manner permitted or required by this Resolution.

Section 19. ADDITIONAL BONDS. The Issuer reserves the right to issue additional parity revenue bonds ("Additional Bonds") for the purpose of completing the acquisition, by purchase and construction, of the Project in accordance with the Contract, and/or for the purpose of refunding any of the Bonds. Such Additional Bonds shall be considered, constitute, and be defined as "Bonds", for all purposes of this Resolution and the Contract, and when issued and delivered, they shall be payable from and secured by a first lien on and pledge of the Gross Revenues, in the same manner and to the same extent as the other Bonds; and all of the Bonds shall in all respects be on a parity and of equal dignity. The Additional Bonds may be issued in one or more installments or series, provided, however, that no such installment or series shall be issued unless:

(a) a certificate is executed by the President and Secretary of the Board of Directors of the Issuer to the effect that no default exists in connection with the Contract or any of the covenants or requirements of the resolution or resolutions authorizing the issuance of all then outstanding Bonds, and that the Reserve Fund contains the amount then required to be on deposit therein.

(b) the resolution authorizing the issuance of such installment or series of Additional Bonds shall provide for the payment of the principal of and interest on such Additional Bonds and shall confirm the Reserve Fund, as additional security for all such Additional Bonds, and the Reserve Fund shall be increased to the extent required to cause the Reserve Fund to be maintained in an amount not less than the Required Reserve after the issuance of such then proposed Additional Bonds (or any greater amount as may, at the option of the Issuer, be provided for in any resolution authorizing the issuance of any Additional Bonds), and shall make provision for funding such Reserve Fund from Gross Revenues, or, at the option of the Issuer, from proceeds of such Additional Bonds or other available sources. The Reserve Fund may be funded in whole or in part initially, or may be funded in whole or in part from Gross Revenues by approximately equal periodic payments, not less than annual, and within not more than five years from the date of such then proposed Additional Bonds.

All calculations of principal and interest requirements of any Bonds made in connection with the issuance of any then proposed Additional Bonds shall be made as of the date of such Additional Bonds, and also in making calculations for such purpose, or for any other purpose under any

resolution authorizing any Bonds, the principal amounts of any Bonds which must be redeemed prior to maturity pursuant to any applicable mandatory redemption requirements hall be deemed to be maturing amounts of principal.

Section 20. ACCOUNTS AND RECORDS. The Issuer shall keep proper books of records and accounts, separate from all other records and accounts of the Issuer, in which complete and correct entries shall be made of all transactions relating to the Contract. The Issuer shall have said books audited once each Issuer fiscal year by a Certified Public Accountant.

Section 21. ACCOUNTING REPORTS. Within one hundred fifty days after the close of each Issuer fiscal year hereafter, the Issuer will furnish, without cost, to any owner of at least twenty-five percent (25%) of any outstanding Bonds who may so request, a signed or certified copy of a report by a Certified Public Accountant covering such fiscal year, showing the following information:

(a) A detailed statement of all Gross Revenues;

(b) Balance sheet as of the end of said fiscal year;

(c) Accountant's comment regarding the manner in which the Issuer has complied with the requirements of this Resolution and his recommendations, if any, for any changes or improvements.

Section 22. INSPECTION. Any owner or owners of any Bonds shall have the right at all reasonable times to inspect all records, accounts, and data of the Issuer relating to the Contract and the Funds created by this Resolution.

Section 23. SPECIAL COVENANTS. The Issuer further covenants as follows:

(a) that other than for the payment of the Bonds, the Gross Revenues have not in any manner been pledged to the payment of any debt or obligation of the Issuer.

(b) that while any of the Bonds are outstanding, the Issuer will not, with the exception of the Additional Bonds expressly permitted by this Resolution to be issued, additionally encumber the Gross Revenues, unless said encumbrance is made junior and subordinate in all respects to the liens, pledges, covenants, and agreements of each resolution authorizing the issuance of the Bonds, but the right of the Issuer to issue obligations for any lawful purpose payable from a subordinate lien on the Gross Revenues is specifically recognized and retained.

(c) that the Issuer will carry out all of its obligations under the Contract; and when or if necessary will promptly enforce and cause the City to carry out all of its obligations under the Contract, for the benefit of the Issuer and the owners of the Bonds, by all legal and equitable means, including the use of mandamus proceedings against the City.

Section 24. BONDS ARE SPECIAL OBLIGATIONS. The Bonds shall be special obligations of the Issuer payable from the pledged Gross Revenues, and the registered owner or

owners of the Bonds shall never have the right to demand payment thereof from any source other than as provided for in the Contract and this Bond Resolution. The Issuer is not authorized to, and shall not levy, collect, or use any tax of any nature to pay the principal of or interest on any of the Bonds.

Section 25. AMENDMENT OF RESOLUTION. (a) The holders or owners of Bonds aggregating at least a majority in principal amount of the aggregate principal amount of then outstanding Bonds shall have the right to approve any amendment to any resolution authorizing the issuance of Bonds, which may be deemed necessary or desirable by the Issuer, provided, however, that nothing herein contained shall permit or be construed to permit the amendment of the terms and conditions in said resolutions or in the Bonds so as to:

(1) Make any change in the maturity of the outstanding Bonds;

(2) Reduce the rate of interest borne by any of the outstanding Bonds;

(3) Reduce the amount of the principal payable on the outstanding Bonds;

(4) Modify the terms of payment of principal of or interest on the outstanding Bonds, or impose any conditions with respect to such payment;

(5) Affect the rights of the holders of less than all of the Bonds then outstanding;

(6) Change the minimum percentage of the principal amount of Bonds necessary for consent to such amendment.

(b) If at any time the Issuer shall desire to amend a resolution under this Section, the Issuer shall cause notice of the proposed amendment to be published in a financial newspaper or journal published in the City of New York, New York, or in the City of Austin, Texas, once during each calendar week for at least two successive calendar weeks. Such notice shall briefly set forth the nature of the proposed amendment and shall state that a copy thereof is on file at the principal office of each Paying Agent/Registrar of any Bonds for inspection by all owners of Bonds. Such publication is not required, however, if notice in writing is given to each owner of Bonds.

(c) Whenever at any time not less than thirty days, and within one year, from the date of the first publication of notice or other service of written notice the Issuer shall receive an instrument or instruments executed by the owners of at least a majority in aggregate principal amount of all Bonds and then outstanding, which instrument or instruments shall refer to the proposed amendment described in said notice and which specifically consent to and approve such amendment in substantially the form of the copy thereof on file as aforesaid, the Issuer may adopt the amendatory resolution in substantially the same form.

(d) Upon the adoption of any amendatory resolution pursuant to the provisions of this Section, the resolution being amended shall be deemed to be amended in accordance with the amendatory resolution, and the respective rights, duties, and obligations of the Issuer and all the holders or owners of then outstanding Bonds and all future Bonds shall thereafter be determined, exercised, and enforced hereunder, subject in all respects to such amendment.

(e) Any consent given by the owner of a Bond pursuant to the provisions of this Section shall be irrevocable for a period of six months from the date of the first publication of the notice provided for in this Section, and shall be conclusive and binding upon all future owners of the same Bond during such period. Such consent may be revoked at any time after six months from the date of the first publication of such notice by the owner who gave such consent, or by a successor in title, by filing notice thereof with the Paying Agent/Registrar for such Bond, and the Issuer, but such revocation shall not be effective if the owners of at least a majority in aggregate principal amount of the then outstanding Bonds as in this Section defined have, prior to the attempted revocation, consented to and approved the amendment.

(f) For the purpose of this Section, the ownership of any Bond shall be ascertained by the registration books pertaining thereto kept by the Paying Agent/Registrar therefor. The Issuer may conclusively assume that such holding or ownership continues until written notice to the contrary is served upon the Issuer.

Section 26. DEFEASANCE OF BONDS. (a) The Bonds and the interest thereon shall be deemed to be paid, retired, and no longer outstanding (a "Defeased Bond") within the meaning of this Resolution, except to the extent provided in subsection (d) of this Section, when payment of the principal of such Bond, plus interest thereon to the due date (whether such due date be by reason of maturity, upon redemption, or otherwise) either (i) shall have been made or caused to be made in accordance with the terms thereof (including the giving of any required notice of redemption), or (ii) shall have been provided for on or before such due date by irrevocably depositing with or making available to the Paying Agent/Registrar for such payment (1) lawful money of the United States of America sufficient to make such payment or (2) Government Obligations which mature as to principal and interest in such amounts and at such times as will insure the availability, without reinvestment, of sufficient money to provide for such payment, and when proper arrangements have been made by the Issuer with the Paying Agent/Registrar for the payment of its services until all Defeased Bonds shall have become due and payable. At such time as a Bond shall be deemed to be a Defeased Bond hereunder, as aforesaid, such Bond and the interest thereon shall no longer be secured by, payable from, or entitled to the benefits of, the Gross Revenues as provided in this Resolution, and such principal and interest shall be payable solely from such money or Government Obligations.

(b) Any moneys so deposited with the Paying Agent/Registrar may at the written direction of the Issuer also be invested in Government Obligations, maturing in the amounts and times as hereinbefore set forth, and all income from such Government Obligations received by the Paying Agent/Registrar which is not required for the payment of the Bonds and interest thereon, with respect to which such money has been so deposited, shall be turned over to the Issuer, or deposited as directed in writing by the Issuer.

(c) The term "Government Obligations" as used in this Section shall mean (i) direct, noncallable obligations of the United States of America, including obligations that are unconditionally guaranteed by the United States of America, (ii) noncallable obligations of an agency or instrumentality of the United States of America, including obligations that are unconditionally guaranteed or insured by the agency or instrumentality and that, on the date the Board of Directors adopts or approves proceedings authorizing the issuance of refunding bonds or otherwise provide for the funding of an escrow to effect the defeasance of the Bonds, are rated as

to investment quality by a nationally recognized investment rating firm not less than "AAA" or its equivalent, and (iii) noncallable obligations of a state or an agency or a county, municipality, or other political subdivision of a state that have been refunded and that, on the date the Board of Directors adopts or approves proceedings authorizing the issuance of refunding bonds or otherwise provide for the funding of an escrow to effect the defeasance of the Bonds, are rated as to investment quality by a nationally recognized investment rating firm no less than "AAA" or its equivalent.

(d) Until all Defeased Bonds shall have become due and payable, the Paying Agent/Registrar shall perform the services of Paying Agent/Registrar for such Defeased Bonds the same as if they had not been defeased, and the Issuer shall make proper arrangements to provide and pay for such services as required by this Resolution.

Section 27. DAMAGED, MUTILATED, LOST, STOLEN, OR DESTROYED BONDS. (a) Replacement Bonds. In the event any outstanding Bond is damaged, mutilated, lost, stolen, or destroyed, the Paying Agent/Registrar shall cause to be printed, executed, and delivered, a new bond of the same principal amount, maturity, and interest rate, as the damaged, mutilated, lost, stolen, or destroyed Bond, in replacement for such Bond in the manner hereinafter provided.

(b) Application for Replacement Bonds. Application for replacement of damaged, mutilated, lost, stolen, or destroyed Bonds shall be made by the registered owner thereof to the Paying Agent/Registrar. In every case of loss, theft, or destruction of a Bond, the registered owner applying for a replacement bond shall furnish to the Issuer and to the Paying Agent/Registrar such security or indemnity as may be required by them to save each of them harmless from any loss or damage with respect thereto. Also, in every case of loss, theft, or destruction of a Bond, the registered owner shall furnish to the Issuer and to the Paying Agent/Registrar evidence to their satisfaction of the loss, theft, or destruction of such Bond, as the case may be. In every case of damage or mutilation of a Bond, the registered owner shall surrender to the Paying Agent/Registrar for cancellation the Bond so damaged or mutilated.

(c) No Default Occurred. Notwithstanding the foregoing provisions of this Section, in the event any such Bond shall have matured, and no default has occurred which is then continuing in the payment of the principal of, redemption premium, if any, or interest on the Bond, the Issuer may authorize the payment of the same (without surrender thereof except in the case of a damaged or mutilated Bond) instead of issuing a replacement Bond, provided security or indemnity is furnished as above provided in this Section.

(d) Charge for Issuing Replacement Bonds. Prior to the issuance of any replacement bond, the Paying Agent/Registrar shall charge the registered owner of such Bond with all legal, printing, and other expenses in connection therewith. Every replacement bond issued pursuant to the provisions of this Section by virtue of the fact that any Bond is lost, stolen, or destroyed shall constitute a contractual obligation of the Issuer whether or not the lost, stolen, or destroyed Bond shall be found at any time, or be enforceable by anyone, and shall be entitled to all the benefits of this Resolution equally and proportionately with any and all other Bonds duly issued under this Resolution.

(e) Authority for Issuing Replacement Bonds. In accordance with Chapter 1201, Texas Government Code, this Section of this Resolution shall constitute authority for the issuance of any

such replacement bond without necessity of further action by the governing body of the Issuer or any other body or person, and the duty of the replacement of such bonds is hereby authorized and imposed upon the Paying Agent/Registrar, and the Paying Agent/Registrar shall authenticate and deliver such Bonds in the form and manner and with the effect, as provided in Section 6(d) of this Resolution for Bonds issued in conversion and exchange for other Bonds.

Section 28. COVENANTS REGARDING TAX-EXEMPTION. (a) Covenant. The Issuer covenants to refrain from any action which would adversely affect, or to take such action to assure, the treatment of the Series 2014 Bonds as obligations described in section 103 of the Code, the interest on which is not includable in the "gross income" of the holder for purposes of federal income taxation. In furtherance thereof, the Issuer covenants as follows:

(1) to take any action to assure that no more than 10 percent of the proceeds of the Series 2014 Bonds or the projects financed therewith (less amounts deposited into a reserve fund, if any) are used for any "private business use," as defined in section 141(b)(6) of the Code, or if more than 10 percent of the proceeds or the projects financed therewith are so used, such amounts, whether or not received by the Issuer, with respect to such private business use, do not, under the terms of this Resolution or any underlying arrangement, directly or indirectly, secure or provide for the payment of more than 10 percent of the debt service on the Series 2014 Bonds, in contravention of section 141(b)(2) of the Code;

(2) to take any action to assure that in the event that the "private business use" described in subsection (a) hereof exceeds five percent of the proceeds of the Series 2014 Bonds or the projects financed therewith (less amounts deposited into a reserve fund, if any) then the amount in excess of five percent is used for a "private business use" which is "related" and not "disproportionate," within the meaning of section 141(b)(3) of the Code, to the governmental use;

(3) to take any action to assure that no amount which is greater than the lesser of $5,000,000, or five percent of the proceeds of the Series 2014 Bonds (less amounts deposited into a reserve fund, if any) is, directly or indirectly, used to finance loans to persons, other than state or local governmental units, in contravention of section 141(c) of the Code;

(4) to refrain from taking any action that would otherwise result in the Series 2014 Bonds being treated as "private activity bonds" within the meaning of section 141(b) of the Code;

(5) to refrain from taking any action that would result in the Series 2014 Bonds being "federally guaranteed" within the meaning of section 149(b) of the Code;

(6) to refrain from using any portion of the proceeds of the Series 2014 Bonds, directly or indirectly, to acquire or to replace funds which were used, directly or indirectly, to acquire investment property (as defined in section 148(b)(2) of the Code) which produces a materially higher yield over the term of the Series 2014 Bonds, other than investment property acquired with --

(A) proceeds of the Series 2014 Bonds invested for a reasonable temporary period of 3 years or less or, in the case of a refunding bond, for a period of 30 days or less until such proceeds are needed for the purpose for which the Series 2014 Bonds are issued,

(B) amounts invested in a bona fide debt service fund, within the meaning of section 1.148-1(b) of the Treasury Regulations, and

(C) amounts deposited in any reasonably required reserve or replacement fund to the extent such amounts do not exceed 10 percent of the stated principal amount (or, in the case of a discount, the issue price) of the Series 2014 Bonds;

(7) to otherwise restrict the use of the proceeds of the Series 2014 Bonds or amounts treated as proceeds of the Series 2014 Bonds, as may be necessary, so that the Series 2014 Bonds do not otherwise contravene the requirements of section 148 of the Code (relating to arbitrage), section 149(g) of the Code (relating to hedge bonds), and, to the extent applicable, section 149(d) of the Code (relating to advance refundings); and

(8) to pay to the United States of America at least once during each five-year period (beginning on the date of delivery of the Series 2014 Bonds) an amount that is at least equal to 90 percent of the "Excess Earnings," within the meaning of section 148(f) of the Code and to pay to the United States of America, not later than 60 days after the Series 2014 Bonds have been paid in full, 100 percent of the amount then required to be paid as a result of Excess Earnings under section 148(f) of the Code.

(b) Rebate Fund. In order to facilitate compliance with the above covenant (a)(8), a "Rebate Fund" is hereby established by the Issuer for the sole benefit of the United States of America, and such fund shall not be subject to the claim of any other person, including without limitation, the bondholders. The Rebate Fund is established for the additional purpose of compliance with section 148 of the Code.

(c) Compliance with Code. For purposes of the foregoing (a)(1) and (a)(2), the Issuer understands that the term "proceeds" includes "disposition proceeds" as defined in the Treasury Regulations. It is the understanding of the Issuer that the covenants contained herein are intended to assure compliance with the Code and any regulations or rulings promulgated by the U.S. Department of the Treasury pursuant thereto. In the event that regulations or rulings are hereafter promulgated which modify or expand provisions of the Code, as applicable to the Series 2014 Bonds, the Issuer will not be required to comply with any covenant contained herein to the extent that such failure to comply, in the opinion of nationally-recognized bond counsel, will not adversely affect the exemption from federal income taxation of interest on the Series 2014 Bonds under section 103 of the Code. In the event that regulations or rulings are hereafter promulgated which impose additional requirements which are applicable to the Series 2014 Bonds, the Issuer agrees to comply with the additional requirements to the extent necessary, in the opinion of nationally-recognized bond counsel, to preserve the exemption from federal income taxation of interest on the Series 2014 Bonds under section 103 of the Code. In furtherance of such intention, the Issuer hereby authorizes and directs its President or General Manager to execute any documents, certificates or reports required by the Code and to make such elections, on behalf of the Issuer,

which may be permitted by the Code as are consistent with the purpose for the issuance of the Series 2014 Bonds. The Issuer covenants to comply with the covenants contained in this Section after defeasance of the Series 2014 Bonds.

(d) Written Procedures. Unless superseded by another action of the Issuer to ensure compliance with the covenants contained herein regarding private business use, remedial actions, arbitrage and rebate, the Issuer hereby adopts and establishes the instructions attached hereto as Exhibit A as their written procedures applicable to Bonds issued pursuant to the Contract.

Section 29. ALLOCATION OF, AND LIMITATION ON, EXPENDITURES FOR THE PROJECT. The Issuer covenants to account for the expenditure of sale proceeds and investment earnings to be used for the Project on its books and records by allocating proceeds to expenditures within 18 months of the later of the date that (1) the expenditure is made, or (2) the Project is completed. The foregoing notwithstanding, the Issuer shall not expend sale proceeds or investment earnings thereon more than 60 days after the later of (1) the fifth anniversary of the delivery of the Series 2014 Bonds, or (2) the date the Series 2014 Bonds are retired, unless the Issuer obtains an opinion of nationally-recognized bond counsel that such expenditure will not adversely affect the tax-exempt status of the Series 2014 Bonds. For purposes hereof, the Issuer shall not be obligated to comply with this covenant if it obtains an opinion that such failure to comply will not adversely affect the excludability for federal income tax purposes from gross income of the interest.

Section 30. DISPOSITION OF PROJECT. The Issuer covenants that the property constituting the Project will not be sold or otherwise disposed in a transaction resulting in the receipt by the Issuer of cash or other compensation, unless the Issuer obtains an opinion of nationally-recognized bond counsel that such sale or other disposition will not adversely affect the tax-exempt status of the Bonds. For purposes of the foregoing, the portion of the property comprising personal property and disposed in the ordinary course shall not be treated as a transaction resulting in the receipt of cash or other compensation. For purposes hereof, the Issuer shall not be obligated to comply with this covenant if it obtains an opinion that such failure to comply will not adversely affect the excludability for federal income tax purposes from gross income of the interest.

Section 31. CUSTODY, APPROVAL, AND REGISTRATION OF INITIAL BOND; CO-BOND COUNSEL'S OPINION, CUSIP NUMBERS, INSURANCE, AND PREAMBLE. The President of the Board of Directors of the Issuer is hereby authorized to have control of the Initial Bond issued hereunder and all necessary records and proceedings pertaining to the Initial Bond pending its delivery and its investigation, examination, and approval by the Attorney General of the State of Texas, and its registration by the Comptroller of Public Accounts of the State of Texas. Upon registration of the Initial Bond said Comptroller of Public Accounts (or a deputy designated in writing to act for said Comptroller) shall manually sign the Comptroller's Registration Certificate on the Initial Bond, and the seal of said Comptroller shall be impressed, or placed in facsimile, on the Initial Bond. The approving legal opinion of the Issuer's Co-Bond Counsel and the assigned CUSIP numbers may, at the option of the Issuer, be printed on the Initial Bond or on any Series 2014 Bonds issued and delivered in conversion of and exchange or replacement of any Series 2014 Bond, but neither shall have any legal effect, and shall be solely for the convenience and information of the registered owners of the Series 2014 Bonds. If insurance is obtained by the Underwriters (as defined in Section 33 hereof) on any of the Series 2014 Bonds, the Initial Bond and such Series 2014

Bonds may bear an appropriate legend concerning insurance as provided by the insurer. The preamble to this Resolution is hereby adopted and made a part hereof for all purposes.

Section 32. INTEREST EARNINGS ON SERIES 2014 BOND PROCEEDS. Interest earnings derived from the investment of proceeds from the sale of the Series 2014 Bonds shall be used along with other bond proceeds for the acquisition and construction of the Project in accordance with the Contract; provided that after completion of the Project, if any of such interest earnings remain on hand, such interest earnings along with any surplus bond proceeds shall be deposited in the Interest and Redemption Fund. It is further provided, however, that any interest earnings on bond proceeds which are required to be rebated to the United States of America pursuant to this Resolution in order to prevent the Series 2014 Bonds from being arbitrage bonds shall be so rebated and not considered as interest earnings for the purposes of this Section.

Section 33. SALE OF SERIES 2014 BONDS. Pursuant to the authorizations in Section 3 hereof, as approved by the Authorized Officer, the Series 2014 Bonds may be sold either pursuant to the taking of bids therefor as provided in the Official Notice of Sale or pursuant to a purchase agreement (the "Purchase Agreement") with a purchaser or purchasers (collectively, the "Underwriters") to be approved by the Authorized Officer, and any supplements thereto which may be necessary to accomplish the issuance of Bonds. Such Purchase Agreement is hereby authorized to be dated, executed and delivered on behalf of the Issuer by an Authorized Officer, with such changes therein as shall be approved by the Authorized Officer, the execution thereof by the Authorized Officer to constitute evidence of such approval. The delegation of authority to the Authorized Officer to approve the final terms of the Series 2014 Bonds as set forth in this Resolution is, and the decisions made by the Authorized Officer pursuant to such delegated authority will be, in the best interests of the Issuer, and the Authorized Officer is authorized to make a finding to such effect in the Approval Certificate.

Section 34. APPROVAL OF OFFICIAL STATEMENT. A Preliminary Official Statement relating to the Series 2014 Bonds, in substantially the form as submitted to the Board of Directors at this meeting, is hereby approved and authorized to be distributed to prospective investors and other interested parties in connection with the underwriting and sale of the Series 2014 Bonds, with such changes therein as shall be approved by the President of the Board of Directors or the General Manager of the Issuer, including such changes as are necessary for distribution as a final Official Statement. It is further officially found, determined, and declared that the statements and representations contained in said Preliminary Official Statement are true and correct in all material respects. The use and distribution by the Underwriters of the Official Statement relating to the Series 2014 Bonds, is hereby approved. For the purpose of review by the Underwriters prior to purchasing the Series 2014 Bonds, the Issuer deems said Preliminary Official Statement to have been "final as of its date" within the meaning of United States Securities and Exchange Commission Rule 15c2-12.

Section 35. ATTORNEY GENERAL FEES. The Issuer hereby authorizes and directs payment, from legally available funds of the Issuer, of the nonrefundable examination fee of the Attorney General of the State of Texas required by Section 1202.004, Texas Government Code, as amended.

Section 36. FURTHER PROCEDURES. The President and the Secretary of the Board of Directors and the General Manager and the Finance Director of the Issuer, and all other officers, employees, and agents of the Issuer, and each of them, shall be and they are hereby expressly authorized, empowered, and directed from time to time and at any time to do and perform all such acts and things and to execute, acknowledge, and deliver in the name and on behalf of the Issuer all such instruments, whether or not herein mentioned, as may be necessary or desirable in order to carry out the terms and provisions of this Resolution, and all details in connection therewith. In case any officer whose signature shall appear on any Series 2014 Bond shall cease to be such officer before the delivery of such Series 2014 Bond, such signature shall nevertheless be valid and sufficient for all purposes the same as if such officer had remained in office until such delivery.

Section 37. CONTINUING DISCLOSURE UNDERTAKING.

(a) Annual Reports.

The Issuer shall provide or cause the City to provide annually to the MSRB, within six months after the end of each fiscal year of the City ending in or after 2014, financial information and operating data (i) of the general type included in the final Official Statement authorized by Section 34 of this Resolution, being the information described in Exhibit B hereto. Any financial information so to be provided shall be (1) prepared in accordance with the accounting principles described in Exhibit B hereto, or such other accounting principles as the City may be required to employ from time to time pursuant to state law or regulation, and (2) audited, if the City commissions an audit of such statements and the audit is completed within the period during which they must be provided. If the audit of such financial statements of the City are not complete within such period, then the Issuer shall provide or cause the City to provide unaudited financial information and operating data which is customarily prepared by the City by the required time to the MSRB, and will provide audited information when and if the audit report becomes available.

If the City changes its fiscal year, the Issuer will notify or cause the City to notify the MSRB the change (and of the date of the new fiscal year end) prior to the next date by which the Issuer or the City otherwise would be required to provide financial information and operating data pursuant to this Section.

The financial information and operating date to be provided pursuant to this Section may be set forth in full in one or more documents or may be included by specific reference to any document (including an official statement or other offering document, if it is available from the MSRB) that theretofore has been provided to the MSRB or filed with the SEC.

(b) Disclosure Event Notices.

The Issuer shall notify or cause the City to notify the MSRB, in a timely manner, of any of the following events with respect to the Series 2014 Bonds, not in excess of ten Business Days after occurrence of the event:

1. Principal and interest payment delinquencies;

2. Non-payment related defaults, if material;

3. Unscheduled draws on debt service reserves reflecting financial difficulties;

4. Unscheduled draws on credit enhancements reflecting financial difficulties;

5. Substitution of credit or liquidity providers, or their failure to perform;

6. Adverse tax opinions, the issuance by the Internal Revenue Service of proposed or final determinations of taxability, Notices of Proposed Issue (IRS Form 5701-TEB) or other material notices or determinations with respect to the tax status of the security, or other material events affecting the tax status of the security;

7. Modifications to the rights of security holders, if material;

8. Bond calls, if material, and tender offers;

9. Defeasances;

10. Release, substitution or sale of property securing repayment of the securities, if material;

11. Rating changes;

12. Bankruptcy, insolvency, receivership or similar event of the City;

13. The consummation of a merger, consolidation, or acquisition involving the City or the sale of all or substantially all of the assets of the City, other than in the ordinary course of business, the entry into a definitive agreement to undertake such an action or the termination of a definitive agreement relating to any such actions, other than pursuant to its terms, if material; and

14. Appointment of a successor or additional trustee or the change of name of a trustee, if material.

The Issuer shall notify or cause the City to notify the MSRB, in a timely manner, of any failure by the Issuer or the City to provide financial information or operating data in accordance with Section 37(a) of this Resolution by the time required by such Section. As used in clause 12 above, the phrase "bankruptcy, insolvency, receivership or similar event" means the appointment of a receiver, fiscal agent, or similar officer for the Issuer in a proceeding under the U.S. Bankruptcy Code or in any other proceeding under state or federal law in which a court or governmental authority has assumed jurisdiction over substantially all of the assets or business of the Issuer, or if jurisdiction has been assumed by leaving the Board of Directors and official or officers of the Issuer in possession but subject to the supervision and orders of a court or governmental authority, or the entry of an order confirming a plan of reorganization, arrangement or liquidation by a court or governmental authority having supervision or jurisdiction over substantially all of the assets or business of the Issuer.

(c) Limitations, Disclaimers, and Amendments.

The Issuer shall be obligated to observe and perform or cause the City to observe and perform the covenants specified in this Section, except that the Issuer in any event will give notice of any deposit made in accordance with Section 26 hereof that causes Series 2014 Bonds no longer to be Outstanding.

The provisions of this Section are for the sole benefit of the Holders and beneficial owners of the Series 2014 Bonds, and nothing in this Section, express or implied, shall give any benefit or any legal or equitable right, remedy, or claim hereunder to any other person. The Issuer undertakes to provide or cause the City to provide only the financial information, operating data, financial statements, and notices which it has expressly agreed to provide pursuant to this Section and does not hereby undertake to provide or cause to be provided any other information that may be relevant or material to a complete presentation of the City's financial results, condition or prospects or hereby undertake to update any information provided in accordance with this Section or otherwise, except as expressly provided herein. The Issuer does not make any representation or warranty concerning such information or its usefulness to a decision to invest in or sell Series 2014 Bonds at any future date.

UNDER NO CIRCUMSTANCES SHALL THE ISSUER BE LIABLE TO THE HOLDER OR BENEFICIAL OWNER OF ANY SERIES 2014 BOND OR ANY OTHER PERSON, IN CONTRACT OR TORT, FOR DAMAGES RESULTING IN WHOLE OR IN PART FROM ANY BREACH BY THE ISSUER, WHETHER NEGLIGENT OR WITHOUT FAULT ON ITS PART, OF ANY COVENANT SPECIFIED IN THIS SECTION, BUT VERY RIGHT AND REMEDY OF ANY SUCH PERSON, IN CONTRACT OR TORT, FOR OR ON ACCOUNT OF ANY SUCH BREACH SHALL BE LIMITED TO AN ACTION FOR MANDAMUS OR SPECIFIC PERFORMANCE.

No default by the Issuer in observing or performing its obligations under this Section shall comprise a breach of or default under this Resolution for purposes of any other provision of this Resolution.

Nothing in this Section is intended or shall act to disclaim, waive, or otherwise limit the duties of the Issuer under federal and state securities laws.

The provisions of this Section may be amended by the Issuer from time to time to adapt to changed circumstances that arise from a change in legal requirements, a change in law, or a change in the identify, nature, status, or type of operations of the City, but only if (1) the provisions of this Section, as so amended, would have permitted an underwriter to purchase or sell Series 2014 Bonds in the primary offering of the Series 2014 Bonds in compliance with the Rule, taking into account any amendments or interpretations of the Rule since such offering as well s such changed circumstances and (2) either (a) the Holders of a majority in aggregate principal amount (or any greater amount required by any other provision of this Resolution that authorizes such an amendment) of the outstanding Series 2014 Bonds consent to such amendment or (b) a Person that is unaffiliated with the Issuer (such as nationally recognized bond counsel) determined that such amendment will not materially impair the interest of the Holders and beneficial owners of the Series 2014 Bonds. If the Issuer so amends the provisions of this Section, it shall include, or cause the City to include, with any amended financial information or operating data next provided in accordance

with Subsection (a) hereof an explanation, in narrative form, of the reason for the amendment and of the impact of any change in the type of financial information or operating data so provided. The Issuer may also amend or repeal the provisions of this continuing disclosure agreement if the SEC amends or repeals the applicable provision of the Rule or a court of final jurisdiction enters judgment that such provisions of the Rule are invalid, but only if and to the extent that the provisions of this sentence would not prevent an underwriter from lawfully purchasing or selling Series 2014 Bonds in the primary offering of the Series 2014 Bonds.

(d) Definitions.

As used in this Section, the following terms have the meanings ascribed to such terms below:

"*MSRB*" means the Municipal Securities Rulemaking Board.

"*Rule*" means SEC Rule 15c2-12, as amended from time to time.

"*SEC*" means the United States Securities and Exchange Commission and any successor to its duties.

Section 38. REPEAL OF CONFLICTING RESOLUTIONS. All resolutions and all parts of any resolutions which are in conflict or inconsistent with this Resolution are hereby repealed and shall be of no further force or effect to the extent of such conflict or inconsistency.

Section 39. PUBLIC NOTICE. It is hereby officially found and determined that public notice of the time, place and purpose of said meeting was given, all as required by the Government Code, Chapter 551.

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EXHIBIT A

WRITTEN PROCEDURES RELATING TO CONTINUING
COMPLIANCE WITH FEDERAL TAX COVENANTS

A. Arbitrage. With respect to the investment and expenditure of the proceeds of the Bonds (the "Obligations") the Issuer's General Manager, Assistant General Manager, and Finance Director (the "Responsible Persons") will :

For Obligations issued for newly acquired property or constructed property:

- instruct the appropriate person or persons that the construction, renovation or acquisition of the facilities must proceed with due diligence and that binding contracts for the expenditure of at least 5%of the proceeds of the Obligations will be entered into within 6 months of the Issue Date;
- monitor that at least 85% of the proceeds of the Obligations to be used for the construction, renovation or acquisition of any facilities are expended within 3 years of the date of delivery of the Obligations ("Issue Date");
- restrict the yield of the investments (other than those in the Reserve Fund) to the yield on the Obligations after 3 years of the Issue Date;
- monitor all amounts deposited into a sinking fund or funds, e.g., the Interest and Redemption Fund and the Reserve Fund, to assure that the maximum amount invested at a yield higher than the yield on the Obligations does not exceed an amount equal to the debt service on the Obligations in the succeeding 12 month period plus a carryover amount equal to one-twelfth of the principal and interest payable on the Obligations for the immediately preceding 12-month period;
- assure that no more than 50% of the proceeds of the Obligations are invested in an investment with a guaranteed yield for 4 years or more;
- assure that the maximum amount of the Reserve Fund invested at a yield higher than the yield on the Obligations will not exceed the lesser of (1) 10% of the original principal amount of the Obligations, (2) 125% of the average annual debt service on the Obligations measured as of the Issue Date, or (3) 100% of the maximum annual debt service on the Obligations as of the Issue Date;

For Obligations issued for refunding purposes:

- monitor the actions of the escrow agent (to the extent an escrow is funded with proceeds) to assure compliance with the applicable provisions of the escrow agreement, including with respect to reinvestment of cash balances;

For all Obligations:

- maintain any official action of the Issuer (such as a reimbursement resolution) stating its intent to reimburse itself or the City with the proceeds of the Obligations any amount expended prior to the Issue Date for the acquisition, renovation or construction of the facilities;

- assure that the applicable information return (e.g., IRS Form 8038-G, 8038-GC, or any successor forms) is timely filed with the IRS;

- assure that, unless excepted from rebate and yield restriction under section 148(f) of the Code, excess investment earnings are computed and paid to the U.S. government at such time and in such manner as directed by the IRS (i) at least every 5 years after the Issue Date and (ii) within 30 days after the date the Obligations are retired.

B. Private Business Use. With respect to the use of the facilities financed or refinanced with the proceeds of the Obligations the Responsible Persons will:

- monitor the date on which the facilities are substantially complete and available to be used for the purpose intended;

- monitor whether, at any time the Obligations are outstanding, any person, other than the Issuer or the City, the employees of the Issuer or the City, the agents of the Issuer or the City or members of the general public has any contractual right (such as a lease, purchase, management or other service agreement) with respect to any portion of the facilities;

- monitor whether, at any time the Obligations are outstanding, any person, other than the Issuer or the City, the employees of the Issuer or the City, the agents of the Issuer or the City or members of the general public has a right to use the output of the facilities (e.g., water, gas, electricity);

- monitor whether, at any time the Obligations are outstanding, any person, other than the Issuer or the City, the employees of the Issuer or the City, the agents of the Issuer or the City or members of the general public has a right to use the facilities to conduct or to direct the conduct of research;

- determine whether, at any time the Obligations are outstanding, any person, other than the Issuer or the City, has a naming right for the facilities or any other contractual right granting an intangible benefit;

- determine whether, at any time the Obligations are outstanding, the facilities are sold or otherwise disposed of; and

- take such action as is necessary to remediate any failure to maintain compliance with the covenants contained in the resolution authorizing the Obligations.

C. Record Retention. The Responsible Persons will maintain or cause to be maintained all records relating to the investment and expenditure of the proceeds of the Obligations and the use of the facilities financed or refinanced thereby for a period ending three (3) years after the complete extinguishment of the Obligations. If any portion of the Obligations is refunded with the proceeds of another series of tax-exempt obligations, such records shall be maintained until the three (3) years after the refunding obligations are completely extinguished. Such records can be maintained in paper or electronic format.

D. Responsible Persons. Each Responsible Person shall receive appropriate training regarding the Issuer's accounting system, contract intake system, facilities management and other systems necessary to track the investment and expenditure of the proceeds and the use of the facilities financed with the proceeds of the Obligations. The foregoing notwithstanding, the Responsible Persons are authorized and instructed to retain such experienced advisors and agents as may be necessary to carry out the purposes of these instructions.

EXHIBIT B

DESCRIPTION OF ANNUAL FINANCIAL INFORMATION

The following information is referred to in Section 37 of this Resolution.

I. Annual Financial Statements and Operating Data

The financial information and operating data with respect to the Issuer to be provided annually in accordance with such Section are as specified (and included in the Appendix or under the headings of the Official Statement and Tables referred to) below:

Table 1 in the Official Statement

Tables 1 through 14 in Appendix B

Appendix C

Accounting Principles

The accounting principles referred to in such Section are the accounting principles described in the notes to the financial statements referred to in paragraph 1 above.

Part B #21

2014

CERTIFICATE FOR RESOLUTION

THE STATE OF TEXAS :
COUNTY OF TARRANT :
TARRANT REGIONAL WATER DISTRICT,
A WATER CONTROL AND IMPROVEMENT DISTRICT :

We, the undersigned officers of the Board of Directors of said District, hereby certify as follows:

1. The Board of Directors of said District convened in REGULAR MEETING ON THE 21ST OF JANUARY, 2014, at the regular designated meeting place, and the roll was called of the duly constituted officers and members of said Board, to-wit:

Victor W. Henderson, President
Jack R. Stevens, Vice President
Martha V. Leonard, Secretary
James W. Lane, Secretary Pro Tem
Mary Kelleher, Director

and all of said persons were present, except the following absentees: none, thus constituting a quorum. Whereupon, among other business, the following was transacted at said Meeting: a written

RESOLUTION AUTHORIZING THE ISSUANCE, SALE, AND DELIVERY OF TARRANT REGIONAL WATER DISTRICT, A WATER CONTROL AND IMPROVEMENT DISTRICT, WATER REVENUE BONDS, SERIES 2014, PLEDGING REVENUES FOR THE PAYMENT OF THE BONDS, APPROVING AN OFFICIAL STATEMENT, AND AUTHORIZING OTHER INSTRUMENTS AND PROCEDURES RELATING THERETO

was duly introduced for the consideration of said Board and read in full. It was then duly moved and seconded that said Resolution be passed; and, after due discussion, said motion, carrying with it the passage of said Resolution, prevailed and carried by the following vote:

AYES: All members of said Board shown present above voted "Aye"; except Kelleher.

NOES: 0.

ABSTENTION: 1

2. That a true, full, and correct copy of the aforesaid Resolution passed at the Meeting described in the above and foregoing paragraph is attached to and follows this Certificate; that said Resolution has been duly recorded in said Board's minutes of said Meeting; that the above and foregoing paragraph is a true, full, and correct excerpt from said Board's minutes of said Meeting pertaining to the passage of said Resolution; that the persons named in the above and foregoing paragraph are the duly chosen, qualified, and acting officers and members of said Board as indicated therein; that each of the officers and members of said Board was duly and sufficiently notified officially and personally, in advance, of the time, place, and purpose of the aforesaid Meeting, and that said Resolution would be introduced and considered for passage at said Meeting, and each of said officers and members consented, in advance, to the holding of said Meeting for such purpose; and that said Meeting was open to the public, and public notice of the time, place, and purpose of said Meeting was given all as required by Chapter 551, Texas Government Code.

SIGNED AND SEALED the 21st day of January, 2014.

Secretary, Board of Directors

President, Board of Directors

(SEAL)

RESOLUTION AUTHORIZING THE ISSUANCE, SALE, AND DELIVERY OF TARRANT REGIONAL WATER DISTRICT, A WATER CONTROL AND IMPROVEMENT DISTRICT, WATER REVENUE BONDS, SERIES 2014, PLEDGING REVENUES FOR THE PAYMENT OF THE BONDS, APPROVING AN OFFICIAL STATEMENT, AND AUTHORIZING OTHER INSTRUMENTS AND PROCEDURES RELATING THERETO

THE STATE OF TEXAS	§
COUNTY OF TARRANT	§
TARRANT REGIONAL WATER DISTRICT	
A WATER CONTROL AND IMPROVEMENT DISTRICT	§

WHEREAS, Tarrant Regional Water District, a Water Control and Improvement District, (formerly known as "Tarrant County Water Control and Improvement District Number One") (the "Issuer" or the "District") is a political subdivision of the State of Texas, being a conservation and reclamation district created and functioning under Article 16, Section 59, of the Texas Constitution, pursuant to the general laws of the State of Texas, including Chapters 49 and 51, Texas Water Code, and pursuant to the provisions of Chapter 268, Acts of 1957, 55th Legislature of Texas, Regular Session, as amended (collectively the "District Act"); and

WHEREAS, the Issuer will authorize the Series 2014 Bonds (hereinafter defined) pursuant to the District Act and Chapter 1371, Texas Govemment Code, as amended; and

WHEREAS, the meeting was open to the public and public notice of the time, place and purpose of said meeting was given pursuant to Chapter 551, Texas Government Code.

THEREFORE, BE IT RESOLVED BY THE BOARD OF DIRECTORS OF TARRANT REGIONAL WATER DISTRICT, A WATER CONTROL AND IMPROVEMENT DISTRICT, THAT:

Section 1. AMOUNT AND PURPOSE OF THE BONDS. The Bonds will be issued for the purpose of obtaining funds to pay for the planning, design, construction, and right of way costs related to the District's Water System, including additional water transmission and pumping facilities; development of new water resources, including costs related to the acquisition of out of state water and associated legal, engineering, and consulting costs; Cedar Creek Dam stabilization, pump station improvements, rebuilding Benbrook dechlorination facility, access bridges, monitoring equipment, generators, switches, instrumentation and other electrical equipment and improvements, and other construction, improvements, and repairs to the District's Water System; (ii) to fund a debt service reserve fund; and (iii) to pay costs of issuance of the Series 2014 Bonds.

Section 2. DESIGNATION OF THE BONDS. Each bond issued pursuant to this Resolution shall be designated: "TARRANT REGIONAL WATER DISTRICT, A WATER CONTROL AND IMPROVEMENT DISTRICT, WATER REVENUE BOND, SERIES 2014." Initially there shall be issued, sold, and delivered hereunder a single fully registered bond, without interest coupons, payable in installments of principal (the "Initial Bond"), but the Initial Bond may be assigned and transferred and/or converted into and exchanged for a like aggregate amount of fully

registered bonds, without interest coupons, having serial maturities, and in the denomination or denominations of $5,000 or any integral multiple of $5,000, all in the manner hereinafter provided. The term "Series 2014 Bonds" as used in this Resolution shall mean and include collectively the Initial Bond and all substitute bonds exchanged therefor, as well as all other substitute bonds and replacement bonds issued pursuant hereto, and the term "Series 2014 Bond" shall mean any of the Series 2014 Bonds.

Section 3. INITIAL DATE, DENOMINATION, NUMBER, MATURITIES, INITIAL REGISTERED OWNER, AND CHARACTERISTICS OF THE INITIAL BOND. (a) As authorized by Chapter 1371, Texas Government Code, as amended, the President of the Board of Directors, the General Manager, and the Finance Director of the Issuer are each hereby designated as an "Authorized Officer" of the Issuer, and each is hereby authorized, appointed, and designated as the officer or employee of the Issuer authorized to act on behalf of the Issuer, which actions shall be evidenced by a certificate executed by such Authorized Officer (the "Approval Certificate") for a period not to extend beyond June 1, 2014, in the selling and delivering of the Series 2014 Bonds and carrying out the other procedures specified in this Resolution, including the use of a book-entry only system with respect to the Series 2014 Bonds and the execution of an appropriate letter of representations if deemed appropriate, the determining and fixing of the date and the date of delivery of the Series 2014 Bonds, any additional or different designation or title by which the Bond shall be known, the price at which the Series 2014 Bonds will be sold (but in no event less than 97% of the principal amount of the Series 2014 Bonds), the principal amount (not exceeding $345,000,000) of the Series 2014 Bonds, the amount of each maturity of principal thereof, the due date of each such maturity (not exceeding forty years from the date of the Series 2014 Bonds), the rate of interest to be borne by each such maturity(but in no event to result in a net effective interest rate on the Series 2014 Bonds exceeding 5.25%), the interest payment dates and periods, the date or dates of optional redemption thereof, any mandatory sinking fund redemption provisions, procuring municipal bond insurance, if any, and approving modifications to this Resolution and executing such instruments, documents and agreements as may be necessary with respect thereto, and all other matters relating to the issuance, sale and delivery of the Series 2014 Bonds. It is further provided, however, that, notwithstanding the foregoing provisions, the Series 2014 Bonds shall not be delivered unless the Series 2014 Bonds are then rated by a nationally recognized rating agency in one of the four highest rating categories for a long-term instrument.

(b) The Initial Bond is hereby authorized to be issued, sold, and delivered hereunder as a single fully registered Bond, without interest coupons, in the denomination and aggregate principal amount set forth in the Approval Certificate (not exceeding $345,000,000), numbered TR-1, payable in annual installments of principal to the initial registered owner thereof or to the registered assignee or assignees of said Bond or any portion or portions thereof (in each case, the "registered owner"), with the annual installments of principal of the Initial Bond to be payable on the dates, respectively, and in the principal amounts, respectively, and may and shall be prepaid or redeemed prior to the respective scheduled due dates of installments of principal thereof, all as set forth in the Approval Certificate.

(c) The Initial Bond (i) if so provided in the Approval Certificate, may and/or shall be prepaid or paid on the respective scheduled due dates of installments of principal thereof, (ii) may be assigned and transferred, (iii) may be converted and exchanged for other bonds, (iv) shall have

the characteristics, and (v) shall be signed and sealed, and the principal of and interest on the Initial Bond shall be payable, all as provided, and in the manner required or indicated, in the FORM OF INITIAL BOND set forth in this Resolution.

Section 4. INTEREST. The unpaid principal balance of the Initial Bond shall bear interest from the date of delivery (the "Issue Date") of the Initial Bond to the Underwriters (as defined in Section 31 hereof) to the respective scheduled due dates, or to the respective dates of prepayment or redemption, if any, of the installments of principal of the Initial Bond, and such interest shall be payable in the manner, at the rates, and on the dates, respectively, as provided in the Approval Certificate and the FORM OF INITIAL BOND set forth in this Resolution.

Section 5. FORM OF INITIAL BOND. The form of the Initial Bond, including the form of Registration Certificate of the Comptroller of Public Accounts of the State of Texas to be endorsed on the Initial Bond, shall be substantially as follows, with blank or bracketed information to be completed or deleted based upon the Approval Certificate:

FORM OF INITIAL BOND

NO. TR-1 $_____*

UNITED STATES OF AMERICA
STATE OF TEXAS
TARRANT REGIONAL WATER DISTRICT,
A WATER CONTROL AND IMPROVEMENT DISTRICT,
WATER REVENUE BOND,
SERIES 2014

TARRANT REGIONAL WATER DISTRICT, A WATER CONTROL AND IMPROVEMENT DISTRICT (the "Issuer"), being a political subdivision of the State of Texas, hereby promises to pay to:

_____*

or to the registered assignee or assignees of this Bond or any portion or portions hereof (in each case, the "registered owner") the aggregate principal amount of

_____*

in annual installments of principal due and payable on March 1 in each of the years, and in the respective principal amounts, as set forth in the following schedule:

Year*	Principal Amount*	Year*	Principal Amount*

* From Approval Certificate.

and to pay interest, calculated on the basis of a 360-day year composed of twelve 30-day months, from the date of initial delivery of this Bond to the Underwriters (as defined in the Bond Resolution (hereinafter defined)), on the balance of each such installment of principal, respectively, from time to time remaining unpaid, at the rates as follows:

Year*	Rate*	Year*	Rate*

with said interest being payable semiannually on each March 1 and September 1, commencing _____*, while this Bond or any portion hereof is outstanding and unpaid.

THE INSTALLMENTS OF PRINCIPAL OF AND THE INTEREST ON this Bond are payable in lawful money of the United States of America, without exchange or collection charges. The installments of principal and the interest on this Bond are payable to the registered owner hereof through the services of THE BANK OF NEW YORK MELLON TRUST COMPANY, NATIONAL ASSOCIATION, DALLAS, TEXAS, which is the "Paying Agent/Registrar" for this Bond. Payment of all principal of and interest on this Bond shall be made by the Paying Agent/Registrar to the registered owner hereof on each principal and/or interest payment date by check, dated as of such date, drawn by the Paying Agent/Registrar on, and payable solely from, funds of the Issuer required by the resolution authorizing the issuance of this Bond (the "Bond Resolution") to be on deposit with the Paying Agent/Registrar for such purpose as hereinafter provided; and such check shall be sent by the Paying Agent/Registrar by United States mail, first-class postage prepaid, on each such principal and/or interest payment date, to the registered owner hereof, at the address of the registered owner, as it appeared at the close of business on the 15th day of the month next preceding each such date (the "Record Date") on the Registration Books kept by the Paying Agent/ Registrar, as hereinafter described. The Issuer covenants with the registered owner of this Bond that on or before each principal and/or interest payment date for this Bond it will make available to the Paying Agent/Registrar, from the "Interest and Redemption Fund" created by the Bond Resolution, the amounts required to provide for the payment, in immediately available funds, of all principal of and interest on this Bond, when due.

IF THE DATE for the payment of the principal of or interest on this Bond shall be a Saturday, Sunday, a legal holiday, or a day on which banking institutions in the City where the Paying Agent/Registrar is located are authorized by law or executive order to close, then the date for such payment shall be the next succeeding day which is not such a Saturday, Sunday, legal holiday, or day on which banking institutions are authorized to close; and payment on such date shall have the same force and effect as if made on the original date payment was due.

THIS BOND has been authorized in accordance with the Constitution and laws of the State of Texas in the principal amount of $_____*, for the purpose of obtaining funds (i) to pay for the planning, design, construction, and right of way costs related to the District's Water System,

* From Approval Certificate.

including additional water transmission and pumping facilities; development of new water resources, including costs related to the acquisition of out of state water and associated legal, engineering, and consulting costs; Cedar Creek Dam stabilization, pump station improvements, rebuilding Benbrook dechlorination facility, access bridges, monitoring equipment, generators, switches, instrumentation and other electrical equipment and improvements, and other construction, improvements, and repairs to the District's Water System; (ii) to fund a debt service reserve fund; and (iii) to pay costs of issuance of the Series 2014 Bonds.

ON _____ 1, ____, or any date thereafter, the unpaid installments of principal of this Bond may be prepaid or redeemed prior to their scheduled due dates, at the option of the Issuer, with funds derived from any available source, as a whole, or in part, and, if in part, the Issuer shall select and designate the installment or installments of principal, and the amount that is to be redeemed, and if less than a whole principal installment is to be called, the Issuer shall direct the Paying Agent/Registrar to call by lot or other customary method of random selection the portion of the principal installment to be redeemed (only in an integral multiple of $5,000), at the redemption price of the principal amount to be prepaid or redeemed, plus accrued interest to the date fixed for prepayment or redemption.

*[THE PRINCIPAL INSTALLMENTS OF THIS BOND maturing on March 1, ____ and March 1, ____ are subject to mandatory prepayment or redemption prior to maturity in part, at a price equal to the principal amount of this Bond or portions hereof to be prepaid or redeemed plus accrued interest to the date of prepayment or redemption, on March 1 in the each of years and in the amounts as follows:

Principal Installment due on March 1, ____

Years	Amounts

Principal Installment due on March 1, ____

Years	Amounts

the amount of any principal installment of this Bond required to be prepaid or redeemed pursuant to the operation of such mandatory prepayment or redemption provisions shall be reduced, at the option of the Issuer, by the principal amount of such principal installment of this Bond which, at

* From Approval Certificate, if applicable.

least 50 days prior to the mandatory prepayment or redemption date (1) shall have been acquired by the Issuer at a price not exceeding such principal amount plus accrued interest to the date of purchase thereof, (2) shall have been purchased by the Paying Agent/Registrar at the request of the Issuer at a price not exceeding such principal amount plus accrued interest to the date of purchase, or (3) shall have been prepaid or redeemed pursuant to the optional prepayment or redemption provisions and not theretofore credited against a mandatory prepayment or redemption requirement.]

AT LEAST 30 days prior to the date fixed for any such prepayment or redemption a written notice of such prepayment or redemption shall be mailed by the Paying Agent/Registrar to the registered owner hereof. By the date fixed for any such prepayment or redemption due provision shall be made by the Issuer with the Paying Agent/Registrar for the payment of the required prepayment or redemption price for this Bond or the portion hereof which is to be so prepaid or redeemed, plus accrued interest thereon to the date fixed for prepayment or redemption. If such written notice of prepayment or redemption is given, and if due provision for such payment is made, all as provided above, this Bond, or the portion thereof which is to be so prepaid or redeemed, thereby automatically shall be treated as prepaid or redeemed prior to its scheduled due date, and shall not bear interest after the date fixed for its prepayment or redemption, and shall not be regarded as being outstanding except for the right of the registered owner to receive the prepayment or redemption price plus accrued interest to the date fixed for prepayment or redemption from the Paying Agent/Registrar out of the funds provided for such payment. The Paying Agent/Registrar shall record in the Registration Books all such prepayments or redemptions of principal of this Bond or any portion hereof.

THIS BOND, to the extent of the unpaid principal balance hereof, or any unpaid portion hereof in any integral multiple of $5,000, may be assigned by the initial registered owner hereof and shall be transferred only in the Registration Books of the Issuer kept by the Paying Agent/Registrar acting in the capacity of registrar for the Bonds, upon the terms and conditions set forth in the Bond Resolution. Among other requirements for such transfer, this Bond must be presented and surrendered to the Paying Agent/ Registrar for cancellation, together with proper instruments of assignment, in form and with guarantee of signatures satisfactory to the Paying Agent/Registrar, evidencing assignment by the initial registered owner of this Bond, or any portion or portions hereof in any integral multiple of $5,000, to the assignee or assignees in whose name or names this Bond or any such portion or portions hereof is or are to be transferred and registered. Any instrument or instruments of assignment satisfactory to the Paying Agent/Registrar may be used to evidence the assignment of this Bond or any such portion or portions hereof by the initial registered owner hereof. A new bond or bonds payable to such assignee or assignees (which then will be the new registered owner or owners of such new Bond or Bonds) or to the initial registered owner as to any portion of this Bond which is not being assigned and transferred by the initial registered owner, shall be delivered by the Paying Agent/Registrar in conversion of and exchange for this Bond or any portion or portions hereof, but solely in the form and manner as provided in the next paragraph hereof for the conversion and exchange of this Bond or any portion hereof. The registered owner of this Bond shall be deemed and treated by the Issuer and the Paying Agent/Registrar as the absolute owner hereof for all purposes, including payment and discharge of liability upon this Bond to the extent of such payment, and the Issuer and the Paying Agent/Registrar shall not be affected by any notice to the contrary.

AS PROVIDED above and in the Bond Resolution, this Bond, to the extent of the unpaid principal balance hereof, may be converted into and exchanged for a like aggregate principal amount of fully registered bonds, without interest coupons, payable to the assignee or assignees duly designated in writing by the initial registered owner hereof, or to the initial registered owner as to any portion of this Bond which is not being assigned and transferred by the initial registered owner, in any denomination or denominations in any integral multiple of $5,000 (subject to the requirement hereinafter stated that each substitute bond issued in exchange for any portion of this Bond shall have a single stated principal maturity date), upon surrender of this Bond to the Paying Agent/Registrar for cancellation, all in accordance with the form and procedures set forth in the Bond Resolution. If this Bond or any portion hereof is assigned and transferred or converted each bond issued in exchange for any portion hereof shall have a single stated principal maturity date corresponding to the due date of the installment of principal of this Bond or portion hereof for which the substitute bond is being exchanged, and shall bear interest at the rate applicable to and borne by such installment of principal or portion thereof. Such bonds, respectively, shall be subject to redemption prior to maturity on the same dates and for the same prices as the corresponding installment of principal of this Bond or portion hereof for which they are being exchanged. No such bond shall be payable in installments, but shall have only one stated principal maturity date. AS PROVIDED IN THE BOND RESOLUTION, THIS BOND IN ITS PRESENT FORM MAY BE ASSIGNED AND TRANSFERRED OR CONVERTED ONCE ONLY, and to one or more assignees, but the bonds issued and delivered in exchange for this Bond or any portion hereof may be assigned and transferred, and converted, subsequently, as provided in the Bond Resolution. The Issuer shall pay the Paying Agent/Registrar's standard or customary fees and charges for transferring, converting, and exchanging this Bond or any portion thereof, but the one requesting such transfer, conversion, and exchange shall pay any taxes or governmental charges required to be paid with respect thereto. The Paying Agent/Registrar shall not be required to make any such assignment, conversion, or exchange (i) during the period commencing with the close of business on any Record Date and ending with the opening of business on the next following principal or interest payment date, or, (ii) with respect to any Bond or portion thereof called for prepayment or redemption prior to maturity, within 45 days prior to its prepayment or redemption date.

IN THE EVENT any Paying Agent/Registrar for this Bond is changed by the Issuer, resigns, or otherwise ceases to act as such, the Issuer has covenanted in the Bond Resolution that it promptly will appoint a competent and legally qualified substitute therefor, and promptly will cause written notice thereof to be mailed to the registered owner of this Bond.

IT IS HEREBY certified, recited, and covenanted that this Bond has been duly and validly authorized, issued, and delivered; that all acts, conditions, and things required or proper to be performed, exist, and be done precedent to or in the authorization, issuance, and delivery of this Bond have been performed, existed, and been done in accordance with law; that this Bond and the interest thereon, are special obligations of the Issuer which, together with other outstanding bonds of the Issuer, are secured by and payable equally and ratably on a parity from a first lien on and pledge of the "Pledged Revenues," as defined in the Bond Resolution, which include the "Net Revenues of the District's Water System," as defined in the Bond Resolution, which specifically include certain amounts to be received by the Issuer (i) pursuant to the "Tarrant County Regional Water Supply Facilities Contract," dated August 29, 1979, among the Issuer and the Cities of Fort Worth and Mansfield, Texas, the "Tarrant County Regional Water Supply Facilities Supplemental

Contract For Trinity River Authority of Texas," dated as of March 12, 1979 between the Issuer and Trinity River Authority of Texas, and the "Tarrant County Regional Water Supply Facilities Amendatory Contract", dated September 1, 1982, among the Issuer, the Cities of Fort Worth, Arlington, and Mansfield, Texas, and Trinity River Authority of Texas, which last named amendatory contract consolidates the previous contracts between such parties with respect to the Issuer's Water System into one instrument and sets forth the entire agreement between such parties with respect to the Issuer's Water System, and (ii) pursuant to contracts with other water customers of the Issuer.

THE ISSUER has reserved the right, subject to the restrictions stated in the Bond Resolution, to issue Additional Bonds payable from and secured by a first lien on and pledge of the "Pledged Revenues" on a parity with this Bond.

THE ISSUER also has reserved the right to amend the Bond Resolution, with the approval of the owners of 51% of the outstanding bonds secured by a first lien on the Pledged Revenues, subject to the restrictions as stated in the Bond Resolution.

THE REGISTERED OWNER hereof shall never have the right to demand payment of this Bond or the interest hereon out of any funds raised or to be raised by taxation or from any source whatsoever other than specified in the Bond Resolution.

BY BECOMING the registered owner of this Bond, the registered owner thereby acknowledges all of the terms and provisions of the Bond Resolution, agrees to be bound by such terms and provisions, acknowledges that the Bond Resolution is duly recorded and available for inspection in the official minutes and records of the governing body of the Issuer, and agrees that the terms and provisions of this Bond and the Bond Resolution constitute a contract between the registered owner hereof and the Issuer.

IN WITNESS WHEREOF, the Issuer has caused this Bond to be signed with the manual or facsimile signature of the President of the Board of Directors of the Issuer and countersigned with the manual or facsimile signature of the Secretary of the Board of Directors of the Issuer, has caused the official seal of the Issuer to be duly impressed, or placed in facsimile, on this Bond and has caused this Bond to be dated as of _____*, 2014.

xxxxxxx	xxxxxxx
Secretary, Board of Directors	President, Board of Directors

(DISTRICT SEAL)

*From Approval Certificate.

FORM OF REGISTRATION CERTIFICATE OF THE
COMPTROLLER OF PUBLIC ACCOUNTS:

COMPTROLLER'S REGISTRATION CERTIFICATE: REGISTER NO.

I hereby certify that this Bond has been examined, certified as to validity, and approved by the Attorney General of the State of Texas, and that this Bond has been registered by the Comptroller of Public Accounts of the State of Texas.

Witness my signature and seal this

_____
Comptroller of Public Accounts of the State of Texas

(COMPTROLLER'S SEAL)

Section 6. CHARACTERISTICS OF THE Series 2014 BONDS. (a) Registration, Transfer, Conversion and Exchange; Authentication. (a) The Issuer shall keep or cause to be kept at the principal corporate trust office of The Bank of New York Mellon Trust Company, National Association, Dallas, Texas (the "Paying Agent/Registrar") books or records for the registration of the transfer, conversion and exchange of the Series 2014 Bonds (the "Registration Books"), and the Issuer hereby appoints the Paying Agent/Registrar as its registrar and transfer agent to keep such books or records and make such registrations of transfers, conversions and exchanges under such reasonable regulations as the Issuer and Paying Agent/Registrar may prescribe; and the Paying Agent/Registrar shall make such registrations, transfers, conversions and exchanges as herein provided. The Paying Agent/Registrar shall obtain and record in the Registration Books the address of the registered owner of each Series 2014 Bond to which payments with respect to the Series 2014 Bonds shall be mailed, as herein provided; but it shall be the duty of each registered owner to notify the Paying Agent/Registrar in writing of the address to which payments shall be mailed, and such interest payments shall not be mailed unless such notice has been given. To the extent possible and under reasonable circumstances, all transfers of Series 2014 Bonds shall be made within three business days after request and presentation thereof. The Issuer shall have the right to inspect the Registration Books during regular business hours of the Paying Agent/Registrar, but otherwise the Paying Agent/Registrar shall keep the Registration Books confidential and, unless otherwise required by law, shall not permit their inspection by any other entity. The Paying Agent/Registrar's standard or customary fees and charges for making such registration, transfer, conversion, exchange and delivery of a substitute Series 2014 Bond or Series 2014 Bonds shall be paid as provided in the FORM OF Series 2014 BOND set forth in this Resolution. Registration of assignments, transfers, conversions and exchanges of Series 2014 Bonds shall be made in the manner provided and with the effect stated in the FORM OF Series 2014 BOND set forth in this Resolution. Each substitute Series 2014 Bond shall bear a letter and/or number to distinguish it from each other Series 2014 Bond.

An authorized representative of the Paying Agent/Registrar shall, before the delivery of any such Series 2014 Bond, date and manually sign the Paying Agent/Registrar's Authentication Certificate, and no such Series 2014 Bond shall be deemed to be issued or outstanding unless such Certificate is so executed. The Paying Agent/Registrar promptly shall cancel all paid Series 2014

Bonds surrendered for conversion and exchange. No additional ordinances, orders, or resolutions need be passed or adopted by the governing body of the Issuer or any other body or person so as to accomplish the foregoing conversion and exchange of any Series 2014 Bond or portion thereof, and the Paying Agent/Registrar shall provide for the printing, execution, and delivery of the substitute Series 2014 Bonds in the manner prescribed herein, and said Series 2014 Bonds shall be of type composition printed on paper of customary weight and strength. Pursuant to Subchapter D, Chapter 1201, Texas Government Code, the duty of conversion and exchange of Series 2014 Bonds as aforesaid is hereby imposed upon the Paying Agent/Registrar, and, upon the execution of said Certificate, the converted and exchanged Series 2014 Bond shall be valid, incontestable, and enforceable in the same manner and with the same effect as the Series 2014 Bonds which initially were issued and delivered pursuant to this Resolution, approved by the Attorney General, and registered by the Comptroller of Public Accounts.

(b) Payment of Series 2014 Bonds and Interest. The Issuer hereby further appoints the Paying Agent/Registrar to act as the paying agent for paying the principal of and interest on the Series 2014 Bonds, all as provided in this Resolution. The Paying Agent/Registrar shall keep proper records of all payments made by the Issuer and the Paying Agent/Registrar with respect to the Series 2014 Bonds.

(c) In General. The Series 2014 Bonds (i) shall be issued in fully registered form, without interest coupons, with the principal of and interest on such Series 2014 Bonds to be payable only to the registered owners thereof, (ii) if so provided in the Approval Certificate, may and/or shall be redeemed prior to their scheduled maturities, (iii) may be transferred and assigned, (iv) may be converted and exchanged for other Series 2014 Bonds, (v) shall have the characteristics, (vi) shall be signed, sealed, executed and authenticated, (vii) shall be payable as to principal and interest, and (viii) shall be administered and the Paying Agent/Registrar and the Issuer shall have certain duties and responsibilities with respect to the Series 2014 Bonds, all as provided, and in the manner and to the effect as required or indicated, in the FORM OF Series 2014 BOND set forth in this Resolution. The Series 2014 Bonds initially issued and delivered pursuant to this Resolution are not required to be, and shall not be, authenticated by the Paying Agent/Registrar, but on each substitute Series 2014 Bond issued in conversion of and exchange for any Series 2014 Bond or Series 2014 Bonds issued under this Resolution the Paying Agent/Registrar shall execute the PAYING AGENT/REGISTRAR'S AUTHENTICATION CERTIFICATE, in the form set forth in the FORM OF Series 2014 BOND.

(d) Substitute Paying Agent/Registrar. The Issuer covenants with the registered owners of the Series 2014 Bonds that at all times while the Series 2014 Bonds are outstanding the Issuer will provide a competent and legally qualified bank, trust company, financial institution, or other agency to act as and perform the services of Paying Agent/Registrar for the Series 2014 Bonds under this Resolution, and that the Paying Agent/Registrar will be one entity. The Issuer reserves the right to, and may, at its option, change the Paying Agent/Registrar upon not less than 120 days written notice to the Paying Agent/Registrar, to be effective not later than 60 days prior to the next principal or interest payment date after such notice. In the event that the entity at any time acting as Paying Agent/Registrar (or its successor by merger, acquisition, or other method) should resign or otherwise cease to act as such, the Issuer covenants that promptly it will appoint a competent and legally qualified bank, trust company, financial institution, or other agency to act as Paying Agent/Registrar

under this Resolution. Upon any change in the Paying Agent/Registrar, the previous Paying Agent/Registrar promptly shall transfer and deliver the Registration Books (or a copy thereof), along with all other pertinent books and records relating to the Series 2014 Bonds, to the new Paying Agent/Registrar designated and appointed by the Issuer. Upon any change in the Paying Agent/Registrar, the Issuer promptly will cause a written notice thereof to be sent by the new Paying Agent/Registrar to each registered owner of the Series 2014 Bonds, by United States mail, first-class postage prepaid, which notice also shall give the address of the new Paying Agent/Registrar. By accepting the position and performing as such, each Paying Agent/Registrar shall be deemed to have agreed to the provisions of this Resolution, and a certified copy of this Resolution shall be delivered to each Paying Agent/Registrar.

(e) Reporting Requirements of Paying Agent/Registrar. To the extent required by the Code and the regulations promulgated and pertaining thereto, it shall be the duty of the Paying Agent/Registrar, on behalf of the Issuer, to report to the owners of the Series 2014 Bonds and the Internal Revenue Service (i) the amount of "reportable payments," if any, subject to backup withholding during each year and the amount of tax withheld, if any, with respect to payments of the Series 2014 Bonds and (ii) the amount of interest or amount treated as interest on the Series 2014 Bonds and required to be included in gross income of the owner thereof.

(f) Book-Entry Only System. The Series 2014 Bonds issued in exchange for the Initial Bond shall be initially issued in the form of a separate single fully registered Series 2014 Bond for each of the maturities thereof. Upon initial issuance, the ownership of each such Series 2014 Bond shall be registered in the name of Cede & Co., as nominee of Depository Trust Company of New York ("DTC"), and except as provided in subsection (f) hereof, all of the outstanding Series 2014 Bonds shall be registered in the name of Cede & Co., as nominee of DTC.

With respect to Series 2014 Bonds registered in the name of Cede & Co., as nominee of DTC, the Issuer and the Paying Agent/Registrar shall have no responsibility or obligation to any DTC Participant or to any person on behalf of whom such a DTC Participant holds an interest on the Series 2014 Bonds. Without limiting the immediately preceding sentence, the Issuer and the Paying Agent/Registrar shall have no responsibility or obligation with respect to (i) the accuracy of the records of DTC, Cede & Co. or any DTC Participant with respect to any ownership interest in the Series 2014 Bonds, (ii) the delivery to any DTC Participant or any other person, other than a Bondholder, as shown on the Registration Books, of any notice with respect to the Series 2014 Bonds, including any notice of redemption, or (iii) the payment to any DTC Participant or any other person, other than a Bondholder, as shown in the Registration Books of any amount with respect to principal of, premium, if any, or interest on, as the case may be, the Series 2014 Bonds. Notwithstanding any other provision of this Resolution to the contrary, the Issuer and the Paying Agent/Registrar shall be entitled to treat and consider the person in whose name each Series 2014 Bond is registered in the Registration Books as the absolute owner of such Series 2014 Bond for the purpose of payment of principal, premium, if any, and interest, as the case may be, with respect to such Series 2014 Bond, for the purpose of giving notices of redemption and other matters with respect to such Series 2014 Bond, for the purpose of registering transfers with respect to such Series 2014 Bond, and for all other purposes whatsoever. The Paying Agent/Registrar shall pay all principal of and interest on the Series 2014 Bonds only to or upon the order of the respective owners, as shown in the Registration Books as provided in this Resolution, or their respective attorneys duly

authorized in writing, and all such payments shall be valid and effective to fully satisfy and discharge the Issuer's obligations with respect to payment of principal of, premium, if any, and interest on, or as the case may be, the Series 2014 Bonds to the extent of the sum or sums so paid. No person other than an owner, as shown in the Registration Books, shall receive a Series 2014 Bond certificate evidencing the obligation of the Issuer to make payments of principal, premium, if any, and interest, as the case may be, pursuant to this Resolution. Upon delivery by DTC to the Paying Agent/Registrar of written notice to the effect that DTC has determined to substitute a new nominee in place of Cede & Co., and subject to the provisions in this Resolution with respect to interest checks being mailed to the registered owner at the close of business on the Record Date, the word "Cede & Co." in this Resolution shall refer to such new nominee of DTC.

(g) Successor Securities Depository; Transfers Outside Book-Entry Only System. In the event that the Issuer or the Paying Agent/Registrar determines that DTC is incapable of discharging its responsibilities described herein and in the representation letter of the Issuer to DTC and that it is in the best interest of the beneficial owners of the Series 2014 Bonds that they be able to obtain certificated Series 2014 Bonds, the Issuer or the Paying Agent/Registrar shall (i) appoint a successor securities depository, qualified to act as such under Section 17(a) of the Securities and Exchange Act of 1934, as amended, notify DTC and DTC Participants of the appointment of such successor securities depository and transfer one or more separate Series 2014 Bonds to such successor securities depository or (ii) notify DTC and DTC Participants of the availability through DTC of Series 2014 Bonds and transfer one or more separate Series 2014 Bonds to DTC Participants having Series 2014 Bonds credited to their DTC accounts. In such event, the Series 2014 Bonds shall no longer be restricted to being registered in the Registration Books in the name of Cede & Co., as nominee of DTC, but may be registered in the name of the successor securities depository, or its nominee, or in whatever name or names Bondholders transferring or exchanging Series 2014 Bonds shall designate, in accordance with the provisions of this Resolution.

(h) Payments to Cede & Co. Notwithstanding any other provision of this Resolution to the contrary, so long as any Series 2014 Bond is registered in the name of Cede & Co., as nominee of DTC, all payments with respect to principal of, premium, if any, and interest on, or as the case may be, such Series 2014 Bond and all notices with respect to such Series 2014 Bond shall be made and given, respectively, in the manner provided in the representation letter of the Issuer to DTC.

Section 7. FORM OF SERIES 2014 SUBSTITUTE BONDS. The form of all Series 2014 Bonds issued in conversion and exchange or replacement of any other Series 2014 Bond or portion thereof, including the form of Paying Agent/Registrar's Certificate to be printed on each of such Series 2014 Bonds, and the Form of Assignment to be printed on each of the Series 2014 Bonds, shall be, respectively, substantially as follows, with blank or bracketed information to be completed or deleted based upon the Approval Certificate, and with such appropriate variations, omissions, or insertions as are permitted or required by this Resolution.

FORM OF SERIES 2014 SUBSTITUTE BOND

THE FOLLOWING TWO BRACKETED PARAGRAPHS ARE TO BE DELETED IF BOND IS NOT BOOK ENTRY ONLY:

[Unless this Bond is presented by an authorized representative of The Depository Trust Company, a New York corporation ("DTC") to the Issuer or its agent for registration of transfer, exchange, or payment, and any Bond issued is registered in the name of Cede & Co. or in such other name as is requested by an authorized representative of DTC (and any payment is made to Cede & Co. or to such other entity as is requested by an authorized representative of DTC), ANY TRANSFER, PLEDGE, OR OTHER USE HEREOF FOR VALUE OR OTHERWISE BY OR TO ANY PERSON IS WRONGFUL inasmuch as the registered owner hereof, Cede & Co., has an interest herein.

As provided in the Indenture referred to herein, until the termination of the system of book-entry-only transfers through DTC, and notwithstanding any other provision of the Indenture to the contrary, this Bond may be transferred, in whole but not in part, only to a nominee of DTC, or by a nominee of DTC to DTC or a nominee of DTC, or by DTC or a nominee of DTC to any successor securities depository or any nominee thereof.]

NO.____ PRINCIPAL AMOUNT
$_____

UNITED STATES OF AMERICA
STATE OF TEXAS
TARRANT REGIONAL WATER DISTRICT,
A WATER CONTROL AND IMPROVEMENT DISTRICT,
WATER REVENUE BOND,
SERIES 2014

INTEREST RATE	MATURITY DATE	ISSUE DATE	CUSIP NO.
%		_____*, 2014	

ON THE MATURITY DATE specified above TARRANT REGIONAL WATER DISTRICT, A WATER CONTROL AND IMPROVEMENT DISTRICT (the "Issuer"), being a political subdivision of the State of Texas, hereby promises to pay to CEDE & CO. or to the registered assignee hereof (either being hereinafter called the "registered owner") the principal amount of _____ DOLLARS and to pay interest thereon, calculated on the basis of a 360-day year composed of twelve 30-day months, from the Issue Date specified above, to the Maturity Date specified above, *[or the date of redemption prior to maturity,] at the interest rate per annum specified above; with interest being payable semiannually on each March 1 and September 1, commencing _____**, except that if the date of authentication of this Bond is later than the first Record Date (hereinafter defined), such principal amount shall bear interest from the interest payment date next preceding the date of authentication, unless such date of authentication is after any Record Date (hereinafter defined) but on or before the next following interest payment date, in which case such principal amount shall bear interest from such next following interest payment date.

* Date of delivery to the Underwriters (as defined in section 31 hereof).
** From Approval Certificate.

THE PRINCIPAL OF AND INTEREST ON this Bond are payable in lawful money of the United States of America, without exchange or collection charges. The principal of this Bond shall be paid to the registered owner hereof upon presentation and surrender of this Bond at maturity or upon the date fixed for its redemption prior to maturity, at the principal corporate trust office of The Bank of New York Mellon Trust Company, National Association, Dallas, Texas, which is the "Paying Agent/Registrar" for this Bond. The payment of interest on this Bond shall be made by the Paying Agent/Registrar to the registered owner hereof on each interest payment date by check dated as of such interest payment date, drawn by the Paying Agent/Registrar on, and payable solely from, funds of the Issuer required by the resolution authorizing the issuance of the Bonds (the "Bond Resolution") to be on deposit with the Paying Agent/Registrar for such purpose as hereinafter provided; and such check shall be sent by the Paying Agent/Registrar by United States mail, first-class postage prepaid, on each such interest payment date, to the registered owner hereof, at the address of the registered owner, as it appeared at the close of business on the 15th day of the month next preceding each such date (the "Record Date") on the Registration Books kept by the Paying Agent/Registrar, as hereinafter described. However, notwithstanding the foregoing provisions, (1) the payment of such interest may be made by any other method acceptable to the Paying Agent/Registrar and requested by, and at the risk and expense of, the registered owner hereof and (2) upon the written request, and at the risk and expense of, the registered owner of any Bond of this Series in the amount of $1,000,000 or more, delivered to the Paying Agent/Registrar not less than 15 days prior to any interest payment date, payment of the interest due on such Bond on such date shall be paid on such date by wire transfer to any designated account in the United States of America which has available to it the wire service facilities of the Federal Reserve Bank. Any accrued interest due upon the redemption of this Bond prior to maturity as provided herein shall be paid to the registered owner at the principal corporate trust office of the Paying Agent/Registrar upon presentation and surrender of this Bond for redemption and payment at the principal corporate trust office of the Paying Agent/Registrar. The Issuer covenants with the registered owner of this Bond that on or before each principal payment date, interest payment date, and accrued interest payment date for this Bond it will make available to the Paying Agent/Registrar, from the "Interest and Redemption Fund" created by the Bond Resolution, the amounts required to provide for the payment, in immediately available funds, of all principal of and interest on the Bonds, when due.

IF THE DATE for the payment of the principal of or interest on this Bond shall be a Saturday, Sunday, a legal holiday, or a day on which banking institutions in the City where the Paying Agent/Registrar is located are authorized by law or executive order to close, then the date for such payment shall be the next succeeding day which is not such a Saturday, Sunday, legal holiday, or day on which banking institutions are authorized to close; and payment on such date shall have the same force and effect as if made on the original date payment was due.

THIS BOND is one of an issue of Bonds dated as of _____*, 2014, authorized in accordance with the Constitution and laws of the State of Texas in the principal amount of $_____* for the purpose of obtaining funds (i) to pay for the planning, design, construction, and right of way costs related to the District's Water System, including additional water transmission and pumping facilities; development of new water resources, including costs related to the acquisition of out of state water and associated legal, engineering, and consulting costs; Cedar Creek Dam stabilization, pump station improvements, rebuilding Benbrook dechlorination facility, access bridges, monitoring equipment, generators, switches, instrumentation and other electrical equipment

and improvements, and other construction, improvements, and repairs to the District's Water System; (ii) to fund a debt service reserve fund; and (iii) to pay costs of issuance of the Series 2014 Bonds.

ON _____ 1, ____, or any date thereafter, the outstanding Bonds may be redeemed prior to their scheduled maturities, at the option of the Issuer, with funds derived from any available source, as a whole, or in part, and, if in part, the Issuer shall select and designate the maturity, or maturities, and the amount that is to be redeemed, and if less than a whole maturity is to be redeemed, the Issuer shall direct the Paying Agent/Registrar to call by lot or other customary method of random selection the Bonds or portions thereof to be redeemed (provided that the Bonds to be redeemed only in integral multiples of $5,000), at the redemption price of the principal amount of the Bonds to be redeemed, plus accrued interest to the date fixed for redemption.

*[THE BONDS maturing on March 1, ____ and March 1, ____ (the "Term Bonds") are subject to mandatory redemption prior to maturity in part, by lot or other customary random method selected by the Paying Agent/Registrar, at a redemption price equal to the principal amount of the Term Bonds or portions thereof to be redeemed plus accrued interest to the redemption date, on June 1 in each of the years and in the principal amounts as follows:

Term Bonds maturing on March 1, ____

Years	Amounts

Term Bonds maturing on March 1, ____

Years	Amounts

The principal amount of the Term Bonds of a maturity required to be redeemed pursuant to the operation of such mandatory redemption provisions shall be reduced, at the option of the Issuer, by the principal amount of the Term Bonds of such maturity which, at least 50 days prior to the mandatory redemption date (1) shall have been acquired by the Issuer at a price not exceeding the principal amount of such Term Bonds plus accrued interest to the date of purchase thereof, and delivered to the Paying Agent/Registrar for cancellation, (2) shall have been purchased and canceled by the Paying Agent/Registrar at the request of the Issuer at a price not exceeding the principal

* From Approval Certificate, if applicable.

amount of such Term Bonds plus accrued interest to the date of purchase, or (3) shall have been redeemed pursuant to the optional redemption provisions and not theretofore credited against a mandatory redemption requirement.]

DURING ANY PERIOD in which ownership of the Bonds is determined by a book entry at a securities depository for the Bonds, if fewer than all of the Bonds of the same maturity and bearing the same interest rate are to be redeemed, the particular Bonds of such maturity and bearing such interest rate shall be selected in accordance with the arrangements between the Issuer and the securities depository.

AT LEAST 30 days prior to the date fixed for any redemption of Bonds or portions thereof prior to maturity at the option of the Issuer, a written notice of such redemption shall be sent by the Paying Agent/Registrar by United States mail, first-class postage prepaid, to the registered owner appearing on the Registration Books at the close of business on the day next preceding the date of mailing of such notice; provided, however, that any notice so mailed shall be conclusively presumed to have been duly given and the failure to receive such notice, or any defect therein shall not affect the validity or effectiveness of the proceedings for the redemption of any Bond at the option of the Issuer. By the date fixed for any such redemption due provision shall be made with the Paying Agent/Registrar for the payment of the required redemption price for the Bonds or portions thereof which are to be so redeemed, plus accrued interest thereon to the date fixed for redemption. If such written notice of redemption is mailed and if due provision for such payment is made, all as provided above, the Bonds or portions thereof which are to be so redeemed thereby automatically shall be treated as redeemed prior to their scheduled maturities, and they shall not bear interest after the date fixed for redemption, and they shall not be regarded as being outstanding except for the right of the registered owner to receive the redemption price plus accrued interest from the Paying Agent/Registrar out of the funds provided for such payment. If a portion of any Bond shall be redeemed a substitute Bond or Bonds having the same maturity date, bearing interest at the same rate, in any denomination or denominations in any integral multiple of $5,000, at the written request of the registered owner, and in aggregate principal amount equal to the unredeemed portion thereof, will be issued to the registered owner upon the surrender thereof for cancellation, at the expense of the Issuer, all as provided in the Bond Resolution.

THIS BOND OR ANY PORTION OR PORTIONS HEREOF IN ANY INTEGRAL MULTIPLE OF $5,000 may be assigned and shall be transferred only in the Registration Books of the Issuer kept by the Paying Agent/Registrar acting in the capacity of registrar for the Bonds, upon the terms and conditions set forth in the Bond Resolution. Among other requirements for such assignment and transfer, this Bond must be presented and surrendered to the Paying Agent/Registrar, together with proper instruments of assignment, in form and with guarantee of signatures satisfactory to the Paying Agent/Registrar, evidencing assignment of this Bond or any portion or portions hereof in any integral multiple of $5,000 to the assignee or assignees in whose name or names this Bond or any such portion or portions hereof is or are to be transferred and registered. The form of Assignment printed or endorsed on this Bond shall be executed by the registered owner or its duly authorized attorney or representative, to evidence the assignment hereof. A new Bond or Bonds payable to such assignee or assignees (which then will be the new registered owner or owners of such new Bond or Bonds), or to the previous registered owner in the case of the assignment and transfer of only a portion of this Bond, may be delivered by the Paying Agent/Registrar in

conversion of and exchange for this Bond, all in the form and manner as provided in the next paragraph hereof for the conversion and exchange of other Bonds. The Issuer shall pay the Paying Agent/Registrar's standard or customary fees and charges for making such transfer, but the one requesting such transfer shall pay any taxes or other governmental charges required to be paid with respect thereto. The Paying Agent/Registrar shall not be required to make transfers of registration of this Bond or any portion hereof (i) during the period commencing with the close of business on any Record Date and ending with the opening of business on the next following principal or interest payment date, or, (ii) with respect to any Bond or any portion thereof called for redemption prior to maturity, within 45 days prior to its redemption date. The registered owner of this Bond shall be deemed and treated by the Issuer and the Paying Agent/Registrar as the absolute owner hereof for all purposes, including payment and discharge of liability upon this Bond to the extent of such payment, and the Issuer and the Paying Agent/Registrar shall not be affected by any notice to the contrary.

ALL BONDS OF THIS SERIES are issuable solely as fully registered bonds, without interest coupons, in the denomination of any integral multiple of $5,000. As provided in the Bond Resolution, this Bond, or any unredeemed portion hereof, may, at the request of the registered owner or the assignee or assignees hereof, be converted into and exchanged for a like aggregate principal amount of fully registered bonds, without interest coupons, payable to the appropriate registered owner, assignee, or assignees, as the case may be, having the same maturity date, and bearing interest at the same rate, in any denomination or denominations in any integral multiple of $5,000 as requested in writing by the appropriate registered owner, assignee, or assignees, as the case may be, upon surrender of this Bond to the Paying Agent/Registrar for cancellation, all in accordance with the form and procedures set forth in the Bond Resolution. The Issuer shall pay the Paying Agent/Registrar's standard or customary fees and charges for transferring, converting, and exchanging any Bond or any portion thereof, but the one requesting such transfer, conversion, and exchange shall pay any taxes or governmental charges required to be paid with respect thereto as a condition precedent to the exercise of such privilege of conversion and exchange. The Paying Agent/Registrar shall not be required to make any such conversion and exchange *[(i)] during the period commencing with the close of business on any Record Date and ending with the opening of business on the next following principal or interest payment date*[, or, (ii) with respect to any Bond or portion thereof called for redemption prior to maturity, within 45 days prior to its redemption date].

IN THE EVENT any Paying Agent/Registrar for the Bonds is changed by the Issuer, resigns, or otherwise ceases to act as such, the Issuer has covenanted in the Bond Resolution that it promptly will appoint a competent and legally qualified substitute therefor, and promptly will cause written notice thereof to be mailed to the registered owners of the Bonds.

IT IS HEREBY certified, recited, and covenanted that this Bond has been duly and validly authorized, issued, and delivered; that all acts, conditions, and things required or proper to be performed, exist, and be done precedent to or in the authorization, issuance, and delivery of this Bond have been performed, existed, and been done in accordance with law; that this Bond and the interest thereon, are special obligations of the Issuer which, together with other outstanding bonds of the Issuer, are secured by and payable equally and ratably on a parity from a first lien on and pledge of the "Pledged Revenues," as defined in the Bond Resolution, which include the "Net

Revenues of the District's Water System," as defined in the Bond Resolution, which specifically include certain amounts to be received by the Issuer (i) pursuant to the "Tarrant County Regional Water Supply Facilities Contract", dated August 29, 1979, among the Issuer and the Cities of Fort Worth and Mansfield, Texas, the "Tarrant County Regional Water Supply Facilities Supplemental Contract For Trinity River Authority of Texas," dated as of March 12, 1979 between the Issuer and Trinity River Authority of Texas, and the "Tarrant County Regional Water Supply Facilities Amendatory Contract," dated September 1, 1982, among the Issuer, the Cities of Fort Worth, Arlington, and Mansfield, Texas, and Trinity River Authority of Texas, which last named amendatory contract consolidates the previous contracts between such parties with respect to the Issuer's Water System into one instrument and sets forth the entire agreement between such parties with respect to the Issuer's Water System, and (ii) pursuant to contracts with other water customers of the Issuer.

THE ISSUER has reserved the right, subject to the restrictions stated in the Bond Resolution, to issue Additional Bonds payable from and secured by a first lien on and pledge of the "Pledged Revenues" on a parity with this Bond.

THE ISSUER also has reserved the right to amend the Bond Resolution, with the approval of the owners of 51% of the outstanding bonds secured by a first lien on the Pledged Revenues, subject to the restrictions stated in the Bond Resolution.

THE REGISTERED OWNER hereof shall never have the right to demand payment of this Bond or the interest hereon out of any funds raised or to be raised by taxation or from any source whatsoever other than as specified in the Bond Resolution.

BY BECOMING the registered owner of this Bond, the registered owner thereby acknowledges all of the terms and provisions of the Bond Resolution, agrees to be bound by such terms and provisions, acknowledges that the Bond Resolution is duly recorded and available for inspection in the official minutes and records of the governing body of the Issuer, and agrees that the terms and provisions of this Bond and the Bond Resolution constitute a contract between each registered owner hereof and the Issuer.

IN WITNESS WHEREOF, the Issuer has caused this Bond to be signed with the facsimile signature of the President of the Board of Directors of the Issuer and countersigned with the facsimile signature of the Secretary of the Board of Directors of the Issuer, and has caused the official seal of the Issuer to be duly impressed, or placed in facsimile, on this Bond.

XXXXXXX	XXXXXXX
Secretary, Board of Directors	President, Board of Directors

(DISTRICT SEAL)

FORM OF PAYING AGENT/REGISTRAR'S AUTHENTICATION CERTIFICATE

PAYING AGENT/REGISTRAR'S AUTHENTICATION CERTIFICATE

(To be executed if this Bond is not accompanied by an executed Registration Certificate of the Comptroller of Public Accounts of the State of Texas)

It is hereby certified that this Bond has been issued under the provisions of the Bond Resolution described in the text of this Bond; and that this Bond has been issued in conversion or replacement of, or in exchange for, a bond, bonds, or a portion of a bond or bonds of a Series which originally was approved by the Attorney General of the State of Texas and registered by the Comptroller of Public Accounts of the State of Texas.

Dated

THE BANK OF NEW YORK MELLON TRUST COMPANY, NATIONAL ASSOCIATION,
Dallas, Texas

By _____
Authorized Representative

FORM OF ASSIGNMENT

ASSIGNMENT

FOR VALUE RECEIVED, the undersigned sells, assigns and transfers unto

Please Insert Social Security or
Other Identifying Number of Assignee
/_____/

_____
(Name and Address of Assignee)
the within Bond and does hereby irrevocably constitute and appoint _____ to transfer said Bond on the books kept for registration thereof with full power of substitution in the premises.

Date: _____

_____

Signature Guaranteed: _____

NOTICE: The signature to this assignment must correspond with the name as it appears upon the face of the within Bond in every particular, without alteration or enlargement or any change whatever; and

NOTICE: Signature(s) must be guaranteed by an eligible guarantor institution participating in a Securities Transfer Association recognized signature guarantee program.

Section 8. ADDITIONAL DEFINITIONS. In addition to the definitions heretofore provided for, the following terms as used in this Resolution shall have the meanings set forth below, unless the text hereof specifically indicates otherwise:

The term "Additional Bonds" shall mean the additional parity revenue bonds permitted to be authorized in the future on a parity with the Bonds, as hereinafter provided in Sections 21 and 22 hereof.

The term "Board" shall mean the Board of Directors of the District, being the governing body of the District, and it is further resolved that the declarations and covenants of the District contained in this Resolution are made by, and for and on behalf of the Board and the District, and are binding upon the Board and the District for all purposes.

The terms "Bond Resolution" and "Resolution" shall mean this resolution authorizing the Series 2014 Bonds; and it is hereby resolved and provided that Sections 8 through 24 of this Bond Resolution are applicable to all of the Bonds, as hereinafter defined, and substantially restate and are supplemental to and cumulative of Sections 7 through 23 of the Series 2006 Bond Resolution, and Sections 8 through 24 of each of the Series 2008A Bond Resolution, Series 2008B Bond Resolution, Series 2009 Bond Resolution, Series 2010 Bond Resolution, Series 2010A Bond Resolution, Series 2010B Bond Resolution, Series 2012 Bond Resolution, and Series 2012A Bond Resolution, with the appropriate changes and additions which are required with respect to the issuance of the Series 2014 Bonds.

The term "Bonds" shall mean collectively (i) the unpaid and unrefunded Series 2006 Bonds, Series 2008A Bonds, Series 2008B Bonds, Series 2009 Bonds, Series 2010 Bonds, Series 2010A Bonds, Series 2010B Bonds, Series 2012 Bonds, and Series 2012A Bonds to be outstanding at any time after the delivery of the Initial Bond, and (ii) the Series 2014 Bonds.

The term "Contracts" shall mean collectively: (a) the "Tarrant County Regional Water Supply Facilities Contract", dated as of August 29, 1979, among the District and the Cities of Fort Worth and Mansfield, Texas, the "Tarrant County Regional Water Supply Facilities Supplemental Contract For Trinity River Authority of Texas", dated as of March 12, 1979, between the District and Trinity River Authority of Texas, and the "Tarrant County Regional Water Supply Facilities Amendatory Contract", dated September 1, 1982, among the District, the Cities of Fort Worth, Arlington, and Mansfield, Texas, and Trinity River Authority of Texas, which last named amendatory contract consolidates the previous contracts between such parties with respect to the System into one instrument and sets forth the entire agreement between such parties with respect to the System; and (b) all water supply contracts heretofore or hereafter executed between the District and other cities and customers in connection with the District's Water System.

The terms "District" and "Issuer" shall mean Tarrant Regional Water District, a Water Control and Improvement District.

The term "District's Water System," "Issuer's Water System," or "System" shall mean all of the District's existing water storage, treatment, transportation, distribution, and supply facilities, including all dams, reservoirs, and other properties, wherever located, (a) which are currently being used for water supply purposes and, to the extent financed with the proceeds from the sale of the

Bonds or Additional Bonds or moneys from the Contingency Fund (hereinafter created), all facilities acquired or constructed in the future, and all improvements to any of the foregoing, and (b) all other facilities which in the future are deliberately and specifically, at the option of the Board, made a part of the System by resolution of the Board, but such term does not include any oil, gas, and other mineral properties owned by the District or property disposed of from time to time in accordance with the provisions of Section 23(g) hereof, provided that any property acquired in substitution therefor shall be included in the System, along with all repairs to and other replacements of the System. In particular such term includes and shall include (i) all of the District's existing Cedar Creek Project, a dam and reservoir on Cedar Creek in Henderson and Kaufman Counties, Texas, and Eagle Mountain Dam and Reservoir and Bridgeport Dam and Reservoir, which are water supply facilities of the District on the West Fork of the Trinity River, Richland-Chambers Reservoir in Navarro and Freestone Counties, Texas, and all transportation, storage, and other facilities related to all of the foregoing and (ii) the Projects which were, or are to be, financed with the proceeds from the sale of bonds originally authorized by the Series 1983 Bond Resolution, the Series 1986 Bond Resolution, Series 1999 Bond Resolution, the Series 2002 Bond Resolution, the Series 2006 Bond Resolution, the Series 2008A Bond Resolution, the Series 2008B Bond Resolution, the Series 2009 Bond Resolution, the Series 2010 Bond Resolution, the Series 2010A Bond Resolution, the Series 2010B Bond Resolution, the Series 2012 Bond Resolution, the Series 2012A Bond Resolution, and the Series 2014 Bond Resolution and made a part of the System. Unless deliberately added to the System by the Board, at its option, in the manner prescribed above, said term does not include any District flood control facilities or facilities which provide waste treatment or other wastewater services of any kind. Said term does not include any facilities acquired or constructed by the District with the proceeds from the issuance of "Special Facilities Bonds," which are hereby defined as being revenue obligations of the District, which are not issued as Additional Bonds, and which are payable from any source, contract, or revenues whatsoever other than the Pledged Revenues; and Special Facilities Bonds may be issued for any lawful purpose and made payable from any source, contract, or revenues whatsoever other than the Pledged Revenues.

The term "Gross Revenues of the System" shall mean all of the revenues, income, rentals, rates, fees, and charges of every nature derived by the Board or the District from the operation and/or ownership of the System (except as hereinafter provided), including specifically all payments and amounts received by the Board or the District from Contracts, and any interest income from the investment of money in any Funds created or maintained pursuant to any resolution authorizing the issuance of Bonds or Additional Bonds, excepting only any Construction Fund created pursuant to any resolution authorizing any Bonds or Additional Bonds. There is excepted from such term, and such term does not include (i) revenues derived by the District from the production of oil, gas, and other minerals owned by the District, or the revenues derived from the granting, sale, or lease of the right to explore for and produce same, or (ii) the royalties, rentals, license fees, and other income (other than from water sales) derived by the District from (a) lands and assets owned by the District as flood control facilities or (b) property of the District at Eagle Mountain Dam and Reservoir and Bridgeport Dam and Reservoir on the West Fork of the Trinity River.

The term "Operating and Maintenance Expenses of the System" or "Current Expenses" shall mean all reasonable and necessary current costs of operation and maintenance of the System including, but not limited to, repairs and replacements, operating personnel, utilities, supervision, engineering, accounting, auditing, legal services, insurance premiums, paying agents fees, and any

other supplies and services, administration of the System, and equipment necessary for proper operation and maintenance of the System, as well as payments made for the use or operation of any property, and payments made by the District in satisfaction of judgments or other liabilities resulting from claims not covered by the District's insurance. Neither depreciation nor any other expense which does not represent a cash expenditure shall be considered an item of Operation and Maintenance Expense.

The terms "Net Revenues of the District's Water System", "Net Revenues of the System", and "Net Revenues" shall mean the Gross Revenues of the System less the Operation and Maintenance Expenses of the System.

The term "Pledged Revenues" shall mean: (a) the Net Revenues of the System and (b) any additional revenues, income, receipts, grants, donations, or other resources, received or to be received from any public or private source, whether pursuant to an agreement or otherwise, which in the future may, at the option of the District, be pledged to the payment of the Bonds or the Additional Bonds.

The term "Series 1983 Bond Resolution" shall mean the resolution adopted by the Board of Directors of the District on May 18, 1983, authorizing the Tarrant County Water Control and Improvement District Number One Water Revenue Bonds, Series 1983.

The term "Series 1986 Bond Resolution" shall mean the resolution adopted by the Board of Directors of the District on July 15, 1986, authorizing the Tarrant County Water Control and Improvement District Number One Water Revenue Bonds, Series 1986.

The term "Series 1999 Bond Resolution" shall mean the Resolution adopted by the Board of Directors of the District on May 18, 1999, authorizing Tarrant Regional Water District, a Water Control and Improvement District, Water Revenue Refunding and Improvement Bonds, Series 1999.

The term "Series 2006 Bond Resolution" shall mean the Resolution adopted by the Board of Directors of the District on March 21, 2006, authorizing Tarrant Regional Water District, a Water Control and Improvement District, Water Revenue Bonds, Series 2006.

The term "Series 2006 Bonds" shall mean all unpaid and unrefunded Series 2006 Bonds authorized by the Series 2006 Bond Resolution.

The term "Series 2008A Bond Resolution" shall mean the Resolution adopted by the Board of Directors of the District on June 17, 2008, authorizing Tarrant Regional Water District, a Water Control and Improvement District, Water Revenue Bonds, Series 2008A.

The term "Series 2008A Bonds" shall mean all unpaid and unrefunded Series 2008A Bonds authorized by the Series 2008A Bond Resolution.

The term "Series 2008B Bond Resolution" shall mean the Resolution adopted by the Board of Directors of the District on June 17, 2008, authorizing Tarrant Regional Water District, a Water Control and Improvement District, Water Revenue Bonds, Series 2008B.

The term "Series 2008B Bonds" shall mean all unpaid and unrefunded Series 2008B Bonds authorized by the Series 2008B Bond Resolution.

The term "Series 2009 Bond Resolution" shall mean the Resolution adopted by the Board of Directors of the District on January 20, 2009, authorizing Tarrant Regional Water District, a Water Control and Improvement District, Water Revenue Refunding and Improvement Bonds, Series 2009.

The term "Series 2009 Bonds" shall mean all unpaid and unrefunded Series 2009 Bonds authorized by the Series 2009 Bond Resolution.

The term "Series 2010 Bond Resolution" shall mean the Resolution adopted by the Board of Directors of the District on January 19, 2010, authorizing Tarrant Regional Water District, a Water Control and Improvement District, Water Revenue Bonds, Series 2010.

The term "Series 2010 Bonds" shall mean all unpaid and unrefunded Series 2010 Bonds authorized by the Series 2010 Bond Resolution.

The term "Series 2010A Bond Resolution" shall mean the Resolution adopted by the Board of Directors of the District on May 18, 2010, authorizing Tarrant Regional Water District, a Water Control and Improvement District, Water Revenue Bonds, Series 2010A.

The term "Series 2010A Bonds" shall mean all unpaid and unrefunded Series 2010A Bonds authorized by the Series 2010A Bond Resolution.

The term "Series 2010B Bond Resolution" shall mean the Resolution adopted by the Board of Directors of the District on May 18, 2010, authorizing Tarrant Regional Water District, a Water Control and Improvement District, Water Revenue Bonds, Series 2010B.

The term "Series 2010B Bonds" shall mean all unpaid and unrefunded Series 2010B Bonds authorized by the Series 2010B Bond Resolution.

The term "Series 2012 Bond Resolution" shall mean the Resolution adopted by the Board of Directors of the District on January 17, 2012, authorizing Tarrant Regional Water District, a Water Control and Improvement District, Water Revenue Refunding and Improvement Bonds, Series 2012.

The term "Series 2012 Bonds" shall mean all unpaid and unrefunded Series 2012 Bonds authorized by the Series 2012 Bond Resolution.

The term "Series 2012A Bond Resolution" shall mean the Resolution adopted by the Board of Directors of the District on September 18, 2012, authorizing Tarrant Regional Water District, a

Water Control and Improvement District, Water Revenue Refunding and Improvement Bonds, Series 2012A.

The term "Series 2012A Bonds" shall mean all unpaid and unrefunded Series 2012A Bonds authorized by the Series 2012A Bond Resolution

The term "Series 2014 Bonds" shall mean collectively the Initial Bond as described and defined in Sections 1, 2, and 3 of this Bond Resolution, and all substitute bonds exchanged therefor, as well as all other substitute bonds and replacement bonds issued pursuant to this Bond Resolution, all as provided for herein; and the Series 2014 Bonds are Additional Bonds issued to be payable from and secured by a first lien on and pledge of the Pledged Revenues equally and ratably on a parity with all of the other Bonds, as permitted by Sections 20 and 21 of the Series 2006 Bond Resolution, and Sections 21 and 22 of the Series 2008A Bond Resolution, the Series 2008B Bond Resolution, the Series 2009 Bond Resolution, the Series 2010 Bond Resolution, the Series 2010A Bond Resolution, the Series 2010B Bond Resolution, the Series 2012 Bond Resolution, and the Series 2012A Bond Resolution.

The terms "year" and "fiscal year" shall mean the District's fiscal year, which currently ends on September 30, but which subsequently may be any other 12 month period hereafter established by the District as a fiscal year for the purposes of the System and any resolution authorizing the Bonds or any Additional Bonds.

Section 9. PLEDGE. (a) That the Bonds, as defined above, and any Additional Bonds, and the interest thereon, are and shall be secured equally and ratably on a parity by and payable from a first lien on and pledge of the Pledged Revenues; and the Series 2014 Bonds are Additional Bonds payable from and secured by a first lien on and pledge of the Pledged Revenues, as permitted by Sections 20 and 21 of the Series 2006 Bond Resolution, and Sections 21 and 22 of the Series 2008A Bond Resolution, Series 2008B Bond Resolution, Series 2009 Bond Resolution, Series 2010 Bond Resolution, Series 2010A Bond Resolution, Series 2010B Bond Resolution, the Series 2012 Bond Resolution, and the Series 2012A Bond Resolution.

(b) That Chapter 1208, Government Code, applies to the issuance of the Bonds and the pledge of the revenues granted by the Issuer under this Section, and is therefore valid, effective, and perfected. Should Texas law be amended at any time while the Bonds are outstanding and unpaid, the result of such amendment being that the pledge of the revenues granted by the Issuer under this Section is to be subject to the filing requirements of Chapter 9, Business & Commerce Code, in order to preserve to the registered owners of the Bonds a security interest in said pledge, the Issuer agrees to take such measures as it determines are reasonable and necessary under Texas law to comply with the applicable provisions of Chapter 9, Business & Commerce Code and enable a filing of a security interest in said pledge to occur.

Section 10. REVENUE FUND. That there has been created and established, and there shall be maintained on the books of the District, and accounted for separate and apart from all other funds of the District, a special fund to be entitled the "Tarrant Regional Water District Water Revenue Bonds Revenue Fund" (hereinafter called the "Revenue Fund"). All Gross Revenues of the System (except investment interest and income from the other Funds hereinafter described and

maintained) shall be credited to the Revenue Fund immediately upon receipt. All Operation and Maintenance Expenses of the System shall be paid from such Gross Revenues credited to the Revenue Fund, as a first charge against same.

Section 11. INTEREST AND REDEMPTION FUND. That for the sole purpose of paying the principal of and interest on all Bonds and any Additional Bonds, as the same come due, either upon redemption or at maturity, there has been created and established, and there shall be maintained, at an official depository bank of the District, a separate fund to be entitled the "Tarrant Regional Water District Revenue Bonds Interest and Redemption Fund" (hereinafter called the "Interest and Redemption Fund").

Section 12. THE CONTINGENCY AND IMPROVEMENT FUND AND THE RESERVE FUND. (a) That there has been created and established and there shall be maintained, at an official depository bank of the District, a separate fund to be entitled the "Tarrant Regional Water District Water Revenue Bonds Contingency and Improvement Fund" (hereinafter called the "Contingency Fund"). The Contingency Fund shall be used solely for the purpose of paying the costs of improvements, enlargements, extensions, additions, or other capital expenditures relating to the System, and unexpected or extraordinary replacements of the System, for which System funds are not otherwise available, or for paying unexpected or extraordinary Operation and Maintenance Expenses of the System for which System Funds are not otherwise available, or for paying principal of and interest on any Bonds or Additional Bonds, when and to the extent the amount in the Interest and Redemption Fund is insufficient for such purpose.

(b) That there has been created and established and there shall be maintained at an official depository bank of the District, a separate fund to be entitled the "Tarrant Regional Water District Water Revenue Bonds Reserve Fund" (hereinafter called the "Reserve Fund"), solely for the further security and benefit of the Bonds and any Additional Bonds. The Reserve Fund shall be used solely for the purpose of (i) finally retiring the last of the Bonds and any Additional Bonds, and (ii) paying principal of and interest on the Bonds or any Additional Bonds when and to the extent the amounts in the Interest and Redemption Fund and Contingency Fund are insufficient for such purpose. Out of proceeds of the Bonds, there shall be deposited to the Reserve Fund an amount of money sufficient to cause the Reserve Fund to contain the Required Amount (hereinafter defined). When and so long as the money and investments in the Reserve Fund are not less in market value than a "Required Amount" equal to the principal and interest requirements of the Bonds during the fiscal year in which such requirements are scheduled to be the greatest, no deposits shall be made to the credit of the Reserve Fund; but when and if the Reserve Fund at any time thereafter contains less than said "Required Amount" in market value, then, subject and subordinate to making the required deposits to the credit of the Interest and Redemption Fund, the District shall transfer from Pledged Revenues and deposit to the credit of the Reserve Fund, semiannually on or before the 25th days of each February and each August of each year, a sum equal to 1/10th of the "Required Amount" until the Reserve Fund is restored to said "Required Amount." So long as the Reserve Fund contains said "Required Amount" in market value, all amounts in excess of said "Required Amount," if any, shall, at least annually, on or before the 25th day of February of each year, be deposited to the credit of the Interest and Redemption Fund.

Section 13. DEPOSITS OF PLEDGED REVENUES; INVESTMENTS. (a) That the Pledged Revenues shall be deposited into the Interest and Redemption Fund, the Reserve Fund, and the Contingency Fund, when and as required by this Bond Resolution, Sections 8 through 24 of which are cumulative of and supplemental to Sections 7 through 23 of the the Series 2006 Bond Resolution, and Sections 8 through 24 of the Series 2008A Bond Resolution, the Series 2008B Bond Resolution, the Series 2009 Bond Resolution, the Series 2010 Bond Resolution, the Series 2010A Bond Resolution, the Series 2010B Bond Resolution, the Series 2012 Bond Resolution, and the Series 2012A Bond Resolution, and Sections 8 through 24 of this Bond Resolution shall be applicable to all of the Bonds.

(b) That money in any Fund maintained pursuant to this Bond Resolution may, at the option of the District, be placed in time deposits or certificates of deposit secured by obligations of the type hereinafter described, or be invested in direct obligations of the United States of America, obligations guaranteed or insured by the United States of America, which, in the opinion of the Attorney General of the United States, are backed by its full faith and credit or represent its general obligations, or invested in indirect obligations of the United States of America, including, but not limited to, evidences of indebtedness issued, insured, or guaranteed by such governmental agencies as the Federal Land Banks, Federal Intermediate Credit Banks, Banks for Cooperatives, Federal Home Loan Banks, Government National Mortgage Association, United States Postal Service, Farmers Home Administration, Federal Home Loan Mortgage Association, Small Business Administration, Federal Housing Association, or Participation Certificates in the Federal Assets Financing Trust; provided that all such deposits and investments shall be made in such manner that the money required to be expended from any Fund will be available at the proper time or times. Such investments shall be valued by the District in terms of current market value as of the 20th day of February of each year. All interest and income derived from such deposits and investments immediately shall be credited to, and any losses debited to, the Fund from which the deposit or investment was made, and surpluses in any Fund shall be disposed of as herein provided. Such investments shall be sold promptly when necessary to prevent any default in connection with the Bonds or Additional Bonds.

Section 14. FUNDS SECURED. That money in all Funds described in this Bond Resolution shall be secured in the manner prescribed by law for securing funds of the District.

Section 15. DEBT SERVICE REQUIREMENTS. (a) That promptly after the delivery of the Initial Bond the District shall cause to be deposited to the credit of the Interest and Redemption Fund all accrued interest, if any, received from the sale and delivery of the Initial Bond, and any such deposit shall be used to pay part of the interest coming due on the Series 2014 Bonds.

(b) That the District shall transfer from the Pledged Revenues and deposit to the credit of the Interest and Redemption Fund the amounts, at the times, as follows:

(1) such amounts, deposited semiannually on or before the 25th day of each February and each August of each year, as will be sufficient, together with other amounts, if any, then on hand in the Interest and Redemption Fund and available for such purpose, to pay the interest scheduled to accrue and come due on all Bonds on the next succeeding interest payment date; and

(2) such amounts, deposited annually, on or before the 25th day of each February, as will be sufficient, together with other amounts, if any, then on hand in the Interest and Redemption Fund and available for such purpose, to pay all principal scheduled to mature and come due on all Bonds on the next succeeding March 1, and to pay all principal of all Bonds, if any, scheduled to be redeemed prior to maturity on the next succeeding March 1 in accordance with the mandatory redemption provisions and schedules set forth in any applicable Bond Resolution.

Section 16. CONTINGENCY REQUIREMENTS. That there is now on deposit to the credit of the Contingency Fund an amount equal to at least $1,100,000. No additional deposits are required to be made to the credit of the Contingency Fund unless and until such amount therein is reduced or depleted. If and when such amount in the Contingency Fund is reduced or depleted then, subject and subordinate to making the required deposits to the credit of the Interest and Redemption Fund and the Reserve Fund, such reduction or depletion shall be restored from amounts which shall be provided for such purpose in the District's Annual Budget for the next ensuing fiscal year or years; provided that the District is not required to budget more than $100,000 for such purpose during any one fiscal year; but the District shall have the right to budget additional amounts for such purpose if it is deemed necessary or advisable by the Board. So long as the Contingency Fund contains money and investments not less than the amount of $1,100,000 in market value, any surplus in the Contingency Fund over said amount shall, semiannually on or before February 15 and August 15 of each year, be withdrawn, deposited to the credit of the Revenue Fund, commingled with other revenues from the operation of the System, and used for any lawful purpose for which Gross Revenues of the System may be used.

Section 17. DEFICIENCIES; EXCESS PLEDGED REVENUES. (a) That if on any occasion there shall not be sufficient Pledged Revenues to make the required deposits into the Interest and Redemption Fund, the Reserve Fund, and the Contingency Fund, then such deficiency shall be made up as soon as possible from the next available Pledged Revenues, or from any other sources available for such purpose.

(b) That, subject to making the required deposits to the credit of the Interest and Redemption Fund, the Reserve Fund, and the Contingency Fund, when and as required by this Bond Resolution, or any resolution authorizing the issuance of Additional Bonds, the excess Pledged Revenues may be used for any lawful purpose.

Section 18. BONDS AND ADDITIONAL BONDS NOT PAYABLE FROM TAXES. It is specifically provided that the District is not authorized to, and shall not, levy, collect, or use any tax of any nature to pay the principal of or interest on any of the Bonds or Additional Bonds.

Section 19. PAYMENT OF BONDS AND ADDITIONAL BONDS. Semiannually on or before each March 1 and September 1 while any of the Bonds or Additional Bonds are outstanding and unpaid, the District shall make available to the paying agents therefor, ratably and on a parity out of the Interest and Redemption Fund, and/or the Contingency Fund, or, from the Reserve Fund, money sufficient to pay such interest on and such principal of the Bonds or Additional Bonds as will

accrue or mature, or which is scheduled to be redeemed prior to maturity, on each such March 1 and September 1, respectively. The paying agents shall destroy all paid Bonds or Additional Bonds, and the coupons, if any, appertaining thereto, and furnish the District with an appropriate certificate of cancellation or destruction.

Section 20. DEFEASANCE OF BONDS. (a) Any Bond and the interest thereon shall be deemed to be paid, retired, and no longer outstanding (a "Defeased Bond") within the meaning of this Resolution, except to the extent provided in subsection (d) of this Section, when payment of the principal of such Bond, plus interest thereon to the due date (whether such due date be by reason of maturity, or otherwise) either (i) shall have been made or caused to be made in accordance with the terms thereof or (ii) shall have been provided for on or before such due date by irrevocably depositing with or making available to the Paying Agent/Registrar in accordance with an escrow agreement or other instrument (the "Future Escrow Agreement") for such payment (1) lawful money of the United States of America sufficient to make such payment or (2) Defeasance Securities that mature as to principal and interest in such amounts and at such times as will insure the availability, without reinvestment, of sufficient money to provide for such payment, and when proper arrangements have been made by the Issuer with the Paying Agent/Registrar for the payment of its services until all Defeased Bonds shall have become due and payable. At such time as a Bond shall be deemed to be a Defeased Bond hereunder, as aforesaid, such Bond and the interest thereon shall no longer be secured by, payable from, or entitled to the benefits of, the revenues herein pledged as provided in this Resolution, and such principal and interest shall be payable solely from such money or Defeasance Securities. Notwithstanding any other provision of this Resolution to the contrary, it is hereby provided that any determination not to redeem Defeased Bonds that is made in conjunction with the payment arrangements specified in subsection 20(a)(i) or (ii) shall not be irrevocable, provided that: (1) in the proceedings providing for such payment arrangements, the Issuer expressly reserves the right to call the Defeased Bonds for redemption; (2) the Issuer gives notice of the reservation of that right to the owners of the Defeased Bonds immediately following the making of the payment arrangements, and (3) the Issuer directs that notice of the reservation be included in any redemption notices that it authorizes.

(b) Any moneys so deposited with the Paying Agent/Registrar may at the written direction of the Issuer also be invested in Defeasance Securities, maturing in the amounts and times as hereinbefore set forth, and all income from such Defeasance Securities received by the Paying Agent/Registrar that is not required for the payment of the Bonds and interest thereon, with respect to which such money has been so deposited, shall be turned over to the Issuer, or deposited as directed in writing by the Issuer. Any Future Escrow Agreement pursuant to which the money and/or Defeasance Securities are held for the payment of Defeased Bonds may contain provisions permitting the investment or reinvestment of such moneys in Defeasance Securities or the substitution of other Defeasance Securities upon the satisfaction of the requirements specified in subsection 20(a)(i) or (ii). All income from such Defeasance Securities received by the Paying Agent/Registrar which is not required for the payment of the Defeased Bonds, with respect to which such money has been so deposited, shall be remitted to the Issuer or deposited as directed in writing by the Issuer.

(c) The term "Defeasance Securities" means (i) direct, noncallable obligations of the United States of America, including obligations that are unconditionally guaranteed by the United

States of America, (ii) noncallable obligations of an agency or instrumentality of the United States of America, including obligations that are unconditionally guaranteed or insured by the agency or instrumentality and that, on the date of the purchase thereof are rated as to investment quality by a nationally recognized investment rating firm not less than AAA or its equivalent, and (iii) noncallable obligations of a state or an agency or a county, municipality, or other political subdivision of a state that have been refunded and that, on the date the governing body of the Issuer adopts or approves the proceedings authorizing the financial arrangements are rated as to investment quality by a nationally recognized investment rating firm not less than AAA or its equivalent.

(d) Until all Defeased Bonds shall have become due and payable, the Paying Agent/Registrar shall perform the services of Paying Agent/Registrar for such Defeased Bonds the same as if they had not been defeased, and the Issuer shall make proper arrangements to provide and pay for such services as required by this Resolution.

(e) In the event that the Issuer elects to defease less than all of the principal amount of Bonds of a maturity, the Paying Agent/Registrar shall select, or cause to be selected, such amount of Bonds by such random method as it deems fair and appropriate.

Section 21. ADDITIONAL BONDS. (a) That the District shall have the right and power at any time and from time to time, and in one or more Series or issues, to authorize, issue, and deliver additional bonds (herein called "Additional Bonds"), which may be payable from and secured by a first lien on and pledge of the Pledged Revenues. No Additional Bonds shall be payable from or secured by ad valorem or other taxes.

(b) Additional Bonds, if and when authorized, issued, and delivered in accordance with the provisions hereof, shall be payable from the Interest and Redemption Fund, and shall be payable from and secured by a first lien on and pledge of the Pledged Revenues, equally and ratably on a parity with the Bonds and all other outstanding Additional Bonds.

(c) That the principal of all Additional Bonds must be scheduled to be paid or mature on March 1 of the years in which such principal is scheduled to be paid or mature; and all interest thereon must be payable on March 1 and September 1.

Section 22. FURTHER REQUIREMENTS FOR ADDITIONAL BONDS. (a) That Additional Bonds shall be issued only in accordance with the provisions hereof, and then applicable laws, and may be issued in any amounts, for any lawful purpose relating to the System, including the refunding of any Bonds or Additional Bonds. No installment, Series, or issue of Additional Bonds shall be issued or delivered unless the President and the Secretary of the Board sign a written certificate to the effect (i) that the District is not in default as to any covenant, condition, or obligation in connection with all outstanding Bonds and Additional Bonds, and the resolutions authorizing the same, (ii) that the Interest and Redemption Fund and the Reserve Fund contain the amount then required to be therein, and (iii) that either (1) the Pledged Revenues in each fiscal year, commencing (A) with the third complete fiscal year following the execution of such certificate or report, or (B) with the fiscal year following the estimated completion date of any project for which the then proposed Additional Bonds are being issued (whichever of (A) or (B) is later) are estimated, based on a report of an independent engineer or firm of engineers, to be at least equal to 1.25 times

the average annual principal and interest requirements of all Bonds and Additional Bonds to be outstanding after delivery of the then proposed Additional Bonds, or (2) based upon an opinion of legal counsel to the District, there are Contracts then in effect pursuant to which parties to such Contracts are obligated to make minimum payments to the District on a "take or pay" basis at such times and in such amounts as shall be necessary to provide to the District Pledged Revenues sufficient to pay when due all principal of and interest on all Bonds and Additional Bonds.

(b) That each resolution authorizing the issuance of Additional Bonds shall confirm the Reserve Fund as additional security for all such Additional Bonds, and the Reserve Fund shall be increased to the extent required to cause the Reserve Fund to be maintained in an amount not less than the principal and interest requirements, during the fiscal year in which such requirements are scheduled to be the greatest, of all Bonds and Additional Bonds to be outstanding after the issuance of such then proposed Additional Bonds (or any greater amount as may, at the option of the District, be provided for in any resolution authorizing the issuance of any Additional Bonds), and shall make provision for funding such Reserve Fund from Pledged Revenues, or, at the option of the District, from bond proceeds or other available sources. Such Reserve Fund may be funded in whole or in part initially, or may be funded in whole or in part from Pledged Revenues by approximately equal periodic payments, not less than annual, and within not more than five years from the date of such then proposed Additional Bonds.

(c) That all calculations of principal and interest requirements of any bonds made in connection with the issuance of any then proposed Additional Bonds shall be made as of the date of such Additional Bonds; and also in making calculations for such purpose, or for any other purpose under any resolution authorizing any Bonds or Additional Bonds, the principal amounts of any Bonds or Additional Bonds which must be redeemed prior to maturity pursuant to any applicable mandatory redemption requirements shall be deemed to be maturing amounts of principal.

Section 23. GENERAL COVENANTS, REPRESENTATIONS, AND WARRANTIES. That the District further covenants, represents, warrants, and agrees that:

(a) PERFORMANCE. It will faithfully perform at all times any and all covenants, undertakings, stipulations, and provisions contained in each resolution authorizing the issuance of the Bonds and any Additional Bonds, and in each and every Bond and Additional Bond; that it will promptly pay or cause to be paid the principal of and interest on every Bond and Additional Bond, on the dates and in the places and manner prescribed in such resolutions and Bonds or Additional Bonds, and that it will, at the times and in the manner prescribed, deposit or cause to be deposited the amounts required to be deposited into the Interest and Redemption Fund; and any holder of the Bonds or Additional Bonds may require the District, its Board, and its officials and employees, to carry out, respect, or enforce the covenants and obligations of each resolution authorizing the issuance of the Bonds and any Additional Bonds, by all legal and equitable means, including specifically, but without limitation, the use and filing of mandamus proceedings, in any court of competent jurisdiction, against the District, its Board, and its officials and employees.

(b) DISTRICT'S LEGAL AUTHORITY. It is a duly created and existing conservation and reclamation district of the State of Texas pursuant to Article 16, Section 59, of the Texas Constitution, and the laws of the State of Texas, and is duly authorized under the laws of the State of Texas to create and issue the Bonds; that all action on its part for the creation and issuance of the

Bonds has been duly and effectively taken, and that the Bonds in the hands of the holders and owners thereof are and will be valid and enforceable obligations of the District in accordance with their terms.

(c) TITLE. It has acquired and constructed, and will operate and maintain the System, and has or will obtain lawful title to, or the lawful right to use and operate, the lands, buildings, and facilities constituting the System, that it warrants that it will defend the title to or lawful right to use and operate, all of the aforesaid lands, buildings, and facilities, and every part thereof, for the benefit of the holders and owners of the Bonds and Additional Bonds against the claims and demands of all persons whomsoever, and is lawfully qualified to pledge the Pledged Revenues to the payment of the Bonds and Additional Bonds in the manner prescribed herein, and has lawfully exercised such rights.

(d) LIENS. It will from time to time and before the same become delinquent pay and discharge all taxes, assessments, and governmental charges, if any, which shall be lawfully imposed upon it, or the System, that it will pay all lawful claims for rents, royalties, labor, materials, and supplies which if unpaid might by law become a lien or charge thereon, the lien of which would be prior to or interfere with the liens hereof, so that the priority of the liens granted hereunder shall be fully preserved in the manner provided herein, and that it will not create or suffer to be created any mechanic's, laborer's, materialman's, or other lien or charge which might or could be prior to the liens hereof, or do or suffer any matter or thing whereby the liens hereof might or could be impaired; provided, however, that no such tax, assessment, or charge, and that no such claims which might be used as the basis of a mechanic's, laborer's, materialman's, or other lien or charge, shall be required to be paid so long as the validity of the same shall be contested in good faith by the District.

(e) OPERATION OF THE SYSTEM. While the Bonds or any Additional Bonds are outstanding and unpaid it will cause the System to be continuously and efficiently operated and maintained in good condition, repair, and working order, and at a reasonable cost.

(f) FURTHER ENCUMBRANCE. While the Bonds or any Additional Bonds are outstanding and unpaid, it will not additionally encumber the Pledged Revenues in any manner, except as permitted hereby in connection with Additional Bonds, unless said encumbrance is made junior and subordinate in all respects to the liens, pledges, covenants, and agreements of each resolution authorizing the issuance of the Bonds and any Additional Bonds; but the right of the District and the Board to issue revenue bonds for any lawful purpose payable from a subordinate lien on the Pledged Revenues is specifically recognized and retained. This Resolution does not and is not intended to affect, limit, or prohibit the issuance of bonds payable solely from ad valorem taxes.

(g) SALE OF PROPERTY. While the Bonds or any Additional Bonds, are outstanding and unpaid, it will maintain its current legal corporate status as a conservation and reclamation district, and it will not sell, convey, mortgage, or in any manner transfer title to, or lease or otherwise dispose of the entire System, or any significant or substantial part thereof; provided that whenever the District deems it necessary to dispose of any real or personal property, machinery, fixtures, or equipment, it may sell or otherwise dispose of such real or personal property, machinery, fixtures, or equipment when it has made arrangements to replace the same or provide substitutes therefor, unless it is determined by resolution of the Board that no such replacement or substitute is necessary; and all proceeds from the sale thereof shall be credited to the Revenue Fund. In all events counsel

to the Issuer shall opine as to the validity of the Resolution, as supplemented and amended and counsel to the Contracting Parties shall opine on the validity of the obligation of the Contracting Parties under the Contract.

(h) INSURANCE. (1) It will carry or cause to be carried such insurance as usually would be carried by corporations or other business entities operating like properties and engaged in similar activities, with a responsible insurance company or companies; provided that no insurance shall be required to the extent that the Board determines, based on the advise of legal counsel, that no substantial liability can or will arise under a particular hazard. At any time while any contractor engaged in construction work shall be fully responsible therefor, the District shall not be required to carry insurance on the works being constructed, if the contractor is required to carry appropriate insurance. All such policies shall be open to the inspection of the owners or holders of the Bonds and Additional Bonds and their representatives at all reasonable times.

(2) Upon the happening of any loss or damage covered by insurance from one or more of said causes, the District shall make due proof of loss and shall do all things necessary or desirable to cause the insuring companies to make payment in full directly to the District. The proceeds of insurance covering such property, together with any other funds necessary and available for such purpose, shall be used forthwith by the District for repairing the property damaged or replacing the property destroyed; provided, however, that if said insurance proceeds and other funds are insufficient for such purpose, then said insurance proceeds pertaining to the System shall be used promptly as follows:

(a) for the redemption prior to maturity of the Bonds and Additional Bonds, if any, ratably in the proportion that the outstanding principal of each Series or issue of Bonds or Additional Bonds bears to the total outstanding principal of all Bonds and Additional Bonds; provided that if on any such occasion the principal of any such Series or issue is not subject to redemption, it shall not be regarded as outstanding in making the foregoing computation; or

(b) if none of the outstanding Bonds or Additional Bonds is subject to redemption, then for the purchase on the open market and retirement of said Bonds and Additional Bonds, in the same proportion as prescribed in the foregoing clause (a), to the extent practicable; provided that the purchase price for any such Bond or Additional Bonds shall not exceed the redemption price of such Bond or Additional Bond on the first date upon which it becomes subject to redemption; or

(c) to the extent that the foregoing clauses (a) and (b) cannot be complied with at the time, the insurance proceeds, or the remainder thereof, shall be deposited in a special and separate trust fund, at an official depository of the District, to be designated the Insurance Account. The Insurance Account shall be held until such time as the foregoing clauses (a) and/or (b) can be complied with, or until other funds become available which, together with the Insurance Account, will be sufficient to make the repairs or replacements originally required, whichever of said events occurs first.

(3) The annual audit hereinafter required shall contain a list of all such insurance policies carried, together with a statement as to whether or not all insurance premiums upon such policies have been paid.

(i) RATE COVENANT. It will fix, establish, maintain, revise (if and when necessary), and collect such rates, charges, and fees for the sale of water from the System and for the use and availability of the System as are necessary to produce Gross Revenues of the System sufficient, together with any other Pledged Revenues and any taxes as may be levied by the District for such purpose, (1) to pay all Operation and Maintenance Expenses of the System, and (2) to produce Pledged Revenues adequate to provide for all payments and deposits required to be made into the Interest and Redemption Fund, the Reserve Fund, and the Contingency Fund, when and as required by the resolutions authorizing all Bonds and Additional Bonds.

(j) RECORDS. It will keep proper books of records and accounts in which full, true, and correct entries will be made of all dealings, activities, and transactions relating to the System, the Pledged Revenues, and all Funds created pursuant to each resolution authorizing the issuance of the Bonds and Additional Bonds; and all books, documents, and vouchers relating thereto shall at all reasonable times be made available for inspection upon request of any bondholder.

(k) AUDITS. Each year while any of the Bonds or Additional Bonds are outstanding, an audit will be made of its books and accounts relating to the System and the Pledged Revenues by an independent certified public accountant or an independent firm of certified public accountants. As soon as practicable after the close of each year, and when said audit has been completed and made available to the District, a copy of such audit for the preceding year shall be mailed to the Municipal Advisory Council of Texas and to any bondholders who shall so request in writing. Such annual audit reports shall be open to the inspection of the owners or holders of the Bonds and Additional Bonds and their agents and representatives at all reasonable times.

(l) GOVERNMENTAL AGENCIES. It will comply with all of the terms and conditions of any and all franchises, permits, and agreements applicable to the System and the Bonds or Additional Bonds entered into between the District and any governmental agency, and the District will take all action necessary to enforce said terms and conditions; and the District will obtain and keep in full force and effect all franchises, permits, and other requirements necessary with respect to the acquisition, construction, operation, and maintenance of the System.

(m) CONTRACTS. It will comply with the terms and conditions of the Contracts and will cause the other parties to the Contracts to comply with all of their obligations thereunder by all lawful means; and the Contracts will not be rescinded, modified, or amended in any way which would have a materially adverse effect on the operation of the System or the rights of the owners of the Bonds and Additional Bonds.

(n) ANNUAL BUDGET. On or before August 1 of each calendar year, it will prepare the preliminary Annual Budget of Operation and Maintenance Expenses of the System for the ensuing fiscal year, and such budget shall include a showing as to the proposed expenditures for such ensuing fiscal year, and shall show the estimated amount of Net Revenues of the System for such year. If the owners or holders of 25% in aggregate principal amount of the Bonds and

Additional Bonds then outstanding shall so request on or before the 15th day of the aforesaid month, the Board shall hold a public hearing on or before the 15th day of the following month, at which any bondholder may appear in person or by agent or attorney and present any objections he may have to the final adoption of such budget. Notice of the time and place of such hearing shall be published twice, once in each of two successive weeks, in a newspaper of general circulation published in the District, with the date of the first publication to be at least fourteen days before the date fixed for the hearing; and copies of such notice shall be mailed at least ten days before the hearing to each bondholder who shall have filed his name and address with the Secretary of the Board for such purpose. The District further covenants that on or before October 1 of each calendar year it will finally adopt the Annual Budget of Operation and Maintenance Expenses of the System for such fiscal year (hereinafter sometimes called the "Annual Budget"). If for any reason the Board shall not have adopted the Annual Budget before the first day of any fiscal year, the budget for the preceding fiscal year shall be deemed to be in force until the adoption of the Annual Budget. The Operation and Maintenance Expenses of the System incurred in any fiscal year will not exceed the reasonable and necessary amount thereof. The District may, at any time deemed necessary by the Board, adopt an Amended or Supplemental Budget for the remainder of the then current fiscal year.

Section 24. AMENDMENT OF RESOLUTION. (a) The holders and registered owners of Bonds and Additional Bonds (hereinafter collectively called "holders") aggregating 51% in principal amount of the aggregate principal amount of then outstanding Bonds and Additional Bonds shall have the right from time to time to approve any amendment to any resolution authorizing the issuance of any Bonds or Additional Bonds, which may be deemed necessary or desirable by the District, provided, however, that nothing herein contained shall permit or be construed to permit the amendment of the terms and conditions in said resolutions or in the Bonds or Additional Bonds so as to:

(1) Make any change in the maturity of the outstanding Bonds or Additional Bonds;

(2) Reduce the rate of interest borne by any of the outstanding Bonds or Additional Bonds;

(3) Reduce the amount of the principal payable on the outstanding Bonds or Additional Bonds;

(4) Modify the terms of payment of principal of or interest on the outstanding Bonds or Additional Bonds, or impose any conditions with respect to such payment;

(5) Effect any change in the rights of the holders of the Bonds and Additional Bonds then outstanding, other than a change which similarly affects all such holders;

(6) Change the minimum percentage of the principal amount of Bonds and Additional Bonds necessary for consent to such amendment.

(b) If at any time the District shall desire to amend a resolution under this Section, the District shall cause notice of the proposed amendment to be published in a financial newspaper or

journal published in The City of New York, New York, once during each calendar week for at least two successive calendar weeks. Such notice shall briefly set forth the nature of the proposed amendment and shall state that a copy thereof is on file at the principal office of each Paying Agent/Registrar for the Bonds and Additional Bonds, for inspection by all holders of Bonds and Additional Bonds. Such publication is not required, however, if notice in writing is given to each holder of Bonds and Additional Bonds.

(c) Whenever at any time not less than thirty days, and within one year, from the date of the first publication of said notice or other service of written notice the District shall receive an instrument or instruments executed by the holders of at least 51% in aggregate principal amount of all Bonds and Additional Bonds then outstanding, which instrument or instruments shall refer to the proposed amendment described in said notice and which specifically consent to and approve such amendment in substantially the form of the copy thereof on file as aforesaid, the District may adopt the amendatory resolution in substantially the same form.

(d) Upon the adoption of any amendatory resolution pursuant to the provisions of this Section, the resolution being amended shall be deemed to be amended in accordance with the amendatory resolution, and the respective rights, duties, and obligations of the District and all the holders of then outstanding Bonds and Additional Bonds and all future Additional Bonds shall thereafter be determined, exercised, and enforced hereunder, subject in all respects to such amendment.

(e) Any consent given by the holder of a Bond or Additional Bonds pursuant to the provisions of this Section shall be irrevocable for a period of six months from the date of the first publication of the notice provided for in this Section, and shall be conclusive and binding upon all future holders of the same Bond or Additional Bond during such period. Such consent may be revoked at any time after six months from the date of the first publication of such notice by the holder who gave such consent, or by a successor in title, by filing notice thereof with each Paying Agent/Registrar for the Bonds and Additional Bonds, and the District, but such revocation shall not be effective if the holders of 51% in aggregate principal amount of the then outstanding Bonds and Additional Bonds as in this Section defined have, prior to the attempted revocation, consented to and approved the amendment.

(f) For the purpose of this Section, the fact of the holding of Bonds or Additional Bonds by any holder of Bonds or Additional Bonds which are not registered and which are payable to bearer, and the amount and numbers of such registered Bonds and Additional Bonds, and the date of their holding same, may be provided by the affidavit of the person claiming to be such holder, or by a certificate executed by any trust company, bank, banker, or any other depository wherever situated showing that at the date therein mentioned such person had on deposit with such trust company, bank, banker, or other depository, the Bonds or Additional Bonds described in such certificate. The District may conclusively assume that such ownership continues until written notice to the contrary is served upon the District. All matters relating to the ownership of registered Bonds and Additional Bonds shall be determined from the bond registration books kept by the registrar therefor.

Section 25. DAMAGED, MUTILATED, LOST, STOLEN, OR DESTROYED Series 2014 BONDS. (a) Replacement Bonds. In the event any outstanding Series 2014 Bond is damaged, mutilated, lost, stolen, or destroyed, the Paying Agent/Registrar shall cause to be printed, executed, and delivered, a new bond of the same principal amount, maturity, and interest rate, as the damaged, mutilated, lost, stolen, or destroyed Bond, in replacement for such Series 2014 Bond in the manner hereinafter provided.

(b) Application for Replacement Bonds. Application for replacement of damaged, mutilated, lost, stolen, or destroyed Series 2014 Bonds shall be made by the registered owner thereof to the Paying Agent/Registrar. In every case of loss, theft, or destruction of a Series 2014 Bond, the registered owner applying for a replacement bond shall furnish to the Issuer and to the Paying Agent/Registrar such security or indemnity as may be required by them to save each of them harmless from any loss or damage with respect thereto. Also, in every case of loss, theft, or destruction of a Series 2014 Bond, the registered owner shall furnish to the Issuer and to the Paying Agent/Registrar evidence to their satisfaction of the loss, theft, or destruction of such Series 2014 Bond, as the case may be. In every case of damage or mutilation of a Series 2014 Bond, the registered owner shall surrender to the Paying Agent/Registrar for cancellation the Series 2014 Bond so damaged or mutilated.

(c) No Default Occurred. Notwithstanding the foregoing provisions of this Section, in the event any such Series 2014 Bond shall have matured, and no default has occurred which is then continuing in the payment of the principal of, redemption premium, if any, or interest on the Series 2014 Bond, the Issuer may authorize the payment of the same (without surrender thereof except in the case of a damaged or mutilated Series 2014 Bond) instead of issuing a replacement Series 2014 Bond, provided security or indemnity is furnished as above provided in this Section.

(d) Charge for Issuing Replacement Bonds. Prior to the issuance of any replacement bond, the Paying Agent/Registrar shall charge the registered owner of such Series 2014 Bond with all legal, printing, and other expenses in connection therewith. Every replacement bond issued pursuant to the provisions of this Section by virtue of the fact that any Series 2014 Bond is lost, stolen, or destroyed shall constitute a contractual obligation of the Issuer whether or not the lost, stolen, or destroyed Series 2014 Bond shall be found at any time, or be enforceable by anyone, and shall be entitled to all the benefits of this Resolution equally and proportionately with any and all other Series 2014 Bonds duly issued under this Resolution.

(e) Authority for Issuing Replacement Bonds. In accordance with Chapter 1201, Texas Government Code, this Section of this Resolution shall constitute authority for the issuance of any such replacement bond without necessity of further action by the governing body of the Issuer or any other body or person, and the duty of the replacement of such bonds is hereby authorized and imposed upon the Paying Agent/Registrar, and the Paying Agent/Registrar shall authenticate and deliver such Series 2014 Bonds in the form and manner and with the effect, as provided in this Resolution for Series 2014 Bonds issued in conversion and exchange for other Series 2014 Bonds.

Section 26. CUSTODY, APPROVAL, AND REGISTRATION OF SERIES 2014 BONDS; BOND COUNSEL'S OPINION, CUSIP NUMBERS, PREAMBLE, AND INSURANCE. The President of the Board of Directors of the Issuer is hereby authorized to have control of the

Initial Bond issued hereunder and all necessary records and proceedings pertaining to said Initial Bond pending its delivery and its investigation, examination, and approval by the Attorney General of the State of Texas, and its registration by the Comptroller of Public Accounts of the State of Texas. Upon registration of said Initial Bond said Comptroller of Public Accounts (or a deputy designated in writing to act for said Comptroller) shall manually sign the Comptroller's Registration Certificate on said Initial Bond, and the seal of said Comptroller shall be impressed, or placed in facsimile, on said Initial Bond. The approving legal opinion of the Issuer's Co-Bond Counsel and the assigned CUSIP numbers may, at the option of the Issuer, be printed on said Initial Bond or on any Series 2014 Bonds issued and delivered in conversion of and exchange or replacement of any Series 2014 Bond, but neither shall have any legal effect, and shall be solely for the convenience and information of the registered owners of the Series 2014 Bonds. The preamble to this Resolution is hereby adopted and made a part hereof for all purposes. If insurance is obtained by the Underwriter (as defined in Section 31 hereof) on any of the Series 2014 Bonds, the Initial Bond and all the Series 2014 Bonds so insured shall bear an appropriate legend concerning insurance as provided by the insurer.

Section 27. COVENANTS REGARDING TAX EXEMPTION. (a) Covenants. The Issuer covenants to take any action necessary to assure, or refrain from any action that would adversely affect, the treatment of the Series 2014 Bonds as obligations described in section 103 of the Internal Revenue Code of 1986, as amended (the "Code"), the interest on which is not includable in the "gross income" of the Series 2014 Bonds holder for purposes of federal income taxation. In furtherance thereof, the Issuer covenants as follows:

(1) to take any action to assure that no more than 10 percent of the proceeds of the Series 2014 Bonds (less amounts deposited to a reserve fund, if any) are used for any "private business use," as defined in section 141(b)(6) of the Code or, if more than 10 percent of the proceeds or the projects financed therewith are so used, such amounts, whether or not received by the Issuer, with respect to such private business use, do not, under the terms of this Resolution or any underlying arrangement, directly or indirectly, secure or provide for the payment of more than 10 percent of the debt service on the Series 2014 Bonds, in contravention of section 141(b)(2) of the Code;

(2) to take any action to assure that in the event that the "private business use" described in subsection (1) hereof exceeds 5 percent of the proceeds of the Series 2014 Bonds or the projects financed therewith (less amounts deposited into a reserve fund, if any) then the amount in excess of 5 percent is used for a "private business use" that is "related" and not "disproportionate," within the meaning of section 141(b)(3) of the Code, to the governmental use;

(3) to take any action to assure that no amount that is greater than the lesser of $5,000,000, or 5 percent of the proceeds of the Series 2014 Bonds (less amounts deposited into a reserve fund, if any) is directly or indirectly used to finance loans to persons, other than state or local governmental units, in contravention of section 141(c) of the Code;

(4) to refrain from taking any action that would otherwise result in the Series 2014 Bonds being treated as "private activity bonds" within the meaning of section 141(b) of the Code;

(5) to refrain from taking any action that would result in the Series 2014 Bonds being "federally guaranteed" within the meaning of section 149(b) of the Code;

(6) to refrain from using any portion of the proceeds of the Series 2014 Bonds, directly or indirectly, to acquire or to replace funds that were used, directly or indirectly, to acquire investment property (as defined in section 148(b)(2) of the Code) that produces a materially higher yield over the term of the Series 2014 Bonds, other than investment property acquired with –

(A) proceeds of the Series 2014 Bonds invested for a reasonable temporary period of 3 years or less or, in the case of a refunding bond, for a period of 90 days or less until such proceeds are needed for the purpose for which the Series 2014 Bonds are issued,

(B) amounts invested in a bona fide debt service fund, within the meaning of section 1.148-1(b) of the Treasury Regulations, and

(C) amounts deposited in any reasonably required reserve or replacement fund to the extent such amounts do not exceed 10 percent of the proceeds of the Series 2014 Bonds;

(7) to otherwise restrict the use of the proceeds of the Series 2014 Bonds or amounts treated as proceeds of the Series 2014 Bonds, as may be necessary, so that the Series 2014 Bonds do not otherwise contravene the requirements of section 148 of the Code (relating to arbitrage) and, to the extent applicable, section 149(d) of the Code (relating to advance refundings);

(8) to pay to the United States of America at least once during each five-year period (beginning on the date of delivery of the Series 2014 Bonds) an amount that is at least equal to 90 percent of the "Excess Earnings," within the meaning of section 148(f) of the Code and to pay to the United States of America, not later than 60 days after the Series 2014 Bonds have been paid in full, 100 percent of the amount then required to be paid as a result of Excess Earnings under section 148(f) of the Code; and

(b) Rebate Fund. In order to facilitate compliance with the above covenant (a)(8), a "Rebate Fund" is hereby established by the Issuer for the sole benefit of the United States of America, and such Fund shall not be subject to the claim of any other person, including without limitation the Bondholders. The Rebate Fund is established for the additional purpose of compliance with section 148 of the Code.

(c) Compliance with Code. For purposes of the foregoing covenants (a)(1) and (a)(2), the Issuer understands that the term "proceeds" includes "disposition proceeds" as defined in the Treasury Regulations and, in the case of refunding Series 2014 Bonds, transferred proceeds (if any) and proceeds of the refunded Series 2014 Bonds expended prior to the date of issuance of the refunding Series 2014 Bonds. It is the understanding of the Issuer that the covenants contained herein are intended to assure compliance with the Code and any regulations or rulings promulgated by the U.S. Department of the Treasury pursuant thereto. In the event that regulations or rulings are hereafter promulgated that modify or expand provisions of the Code, as applicable to the Series 2014 Bonds, the Issuer will not be required to comply with any covenant contained herein to the extent that such failure to comply, in the opinion of nationally recognized bond counsel, will not adversely affect the exemption from federal income taxation of interest on the Series 2014 Bonds under section 103 of the Code. In the event that regulations or rulings are hereafter promulgated that impose additional requirements applicable to the Series 2014 Bonds, the Issuer agrees to comply with the additional requirements to the extent necessary, in the opinion of nationally recognized bond counsel, to preserve the exemption from federal income taxation of interest on the Series 2014 Bonds under section 103 of the Code. In furtherance of such intention, the Issuer hereby authorizes and directs the President of the Board of Directors, the General Manager, or the Director of Finance to execute any documents, certificates or reports required by the Code and to make such elections, on behalf of the Issuer, that may be permitted by the Code as are consistent with the purpose for the issuance of the Series 2014 Bonds.

(d) Written Procedures. Unless superseded by another action of the Issuer to ensure compliance with the covenants contained herein regarding private business use, remedial actions, arbitrage and rebate, the Issuer hereby adopts and establishes the instructions attached hereto as Exhibit A as their written procedures applicable to the Bonds and any Additional Bonds.

Section 28. ALLOCATION OF, AND LIMITATION ON, EXPENDITURES FOR THE PROJECT. The Issuer covenants to account for the expenditure of sale proceeds and investment earnings to be used for the purposes described in Section 1 of this Resolution (the "Project") on its books and records by allocating proceeds to expenditures within 18 months of the later of the date that (1) the expenditure is made, or (2) the Project is completed. The foregoing notwithstanding, the Issuer shall not expend sale proceeds or investment earnings thereon more than 60 days after the earlier of (1) the fifth anniversary of the delivery of the Series 2014 Bonds, or (2) the date the Series 2014 Bonds are retired, unless the Issuer obtains an opinion of nationally-recognized bond counsel that such expenditure will not adversely affect the tax-exempt status of the Series 2014 Bonds. For purposes hereof, the Issuer shall not be obligated to comply with this covenant if it obtains an opinion that such failure to comply will not adversely affect the excludability for federal income tax purposes from gross income of the interest.

Section 29. DISPOSITION OF PROJECT. The Issuer covenants that the property constituting the Project refinanced by the Series 2014 Bonds will not be sold or otherwise disposed in a transaction resulting in the receipt by the Issuer of cash or other compensation, unless the Issuer obtains an opinion of nationally-recognized bond counsel that such sale or other disposition will not adversely affect the tax-exempt status of the Series 2014 Bonds. For purposes of the foregoing, the portion of the property comprising personal property and disposed in the ordinary course shall not be treated as a transaction resulting in the receipt of cash or other compensation. For purposes

hereof, the Issuer shall not be obligated to comply with this covenant if it obtains an opinion that such failure to comply will not adversely affect the excludability for federal income tax purposes from gross income of the interest.

Section 30. CONTINUING DISCLOSURE. (a) Definitions. As used in this Section, the following terms have the meanings ascribed to such terms below:

"*Authority*" means Trinity River Authority.

"*Cities*" means the Cities of Arlington, Fort Worth and Mansfield.

"*MSRB*" means the Municipal Securities Rulemaking Board.

"*Rule*" means SEC Rule 15c2-12, as amended from time to time.

"*SEC*" means the United States Securities and Exchange Commission.

(b) General. Pursuant to a Continuing Disclosure Agreement by and among the Issuer, the Cities, and the Authority, the Issuer, the Cities and the Authority have undertaken for the benefit of the beneficial owners of the Series 2014 Bonds, to the extent set forth therein, to provide continuing disclosure of financial information and operating data with respect to the Issuer, Cities and Authority in accordance with the Rule as promulgated by the SEC.

(c) Annual Reports. (i) The Issuer shall provide annually to the MSRB, within six months after the end of each fiscal year ending in or after 2014, financial information and operating data with respect to the Issuer of the general type included in the final Official Statement authorized by Section 32 of this Resolution, being the information described in Exhibit B. Any financial statements so to be provided shall be prepared in accordance with the accounting principles described in Exhibit B thereto, or such other accounting principles as the Issuer may be required to employ from time to time pursuant to state law or regulation, and audited, if the Issuer commissions an audit of such statements and the audit is completed within the period during which they must be provided. If the audit of such financial statements is not complete within such period, then the Issuer shall provide audited financial statements for the applicable fiscal year to each NRMSIR and any SID, when and if the audit report on such statements become available.

(ii) If the Issuer changes its fiscal year, it will notify the MSRB of the change (and of the date of the new fiscal year end) prior to the next date by which the Issuer otherwise would be required to provide financial information and operating data pursuant to this Section. The financial information and operating data to be provided pursuant to this Section may be set forth in full in one or more documents or may be included by specific reference to any document (including an official statement or other offering document, if it is available from the MSRB) that theretofore has been provided to the MSRB, or filed with the SEC.

(d) Disclosure Event Notices. The Issuer shall notify the MSRB, in a timely manner, of any of the following events with respect to the Series 2014 Bonds, not in excess of ten Business Days after occurrence of the event:

1. Principal and interest payment delinquencies;

2. Non-payment related defaults, if material;

3. Unscheduled draws on debt service reserves reflecting financial difficulties;

4. Unscheduled draws on credit enhancements reflecting financial difficulties;

5. Substitution of credit or liquidity providers, or their failure to perform;

6. Adverse tax opinions, the issuance by the Internal Revenue Service of proposed or final determinations of taxability, Notices of Proposed Issue (IRS Form 5701-TEB) or other material notices or determinations with respect to the tax status of the security, or other material events affecting the tax status of the security;

7. Modifications to the rights of security holders, if material;

8. Bond calls, if material, and tender offers;

9. Defeasances;

10. Release, substitution or sale of property securing repayment of the securities, if material;

11. Rating changes;

12. Bankruptcy, insolvency, receivership or similar event of the Issuer, any of the Cities or the Authority;

13. The consummation of a merger, consolidation, or acquisition involving the Issuer or the sale of all or substantially all of the assets of the Issuer, any of the Cities, or the Authority, other than in the ordinary course of business, the entry into a definitive agreement to undertake such an action or the termination of a definitive agreement relating to any such actions, other than pursuant to its terms, if material; and

14. Appointment of a successor or additional trustee or the change of name of a trustee, if material.

The Issuer shall notify the MSRB, in a timely manner, of any failure by the Issuer to provide financial information or operating data in accordance with Section 30(c) of this Resolution by the time required by such Section. As used in clause 12 above, the phrase "bankruptcy, insolvency, receivership or similar event" means the appointment of a receiver, fiscal agent, or similar officer for the Issuer in a proceeding under the U.S. Bankruptcy Code or in any other proceeding under state or federal law in which a court or governmental authority has assumed jurisdiction over substantially all of the assets or business of the Issuer, or if jurisdiction has been assumed by leaving the Board

of Directors and official or officers of the Issuer in possession but subject to the supervision and orders of a court or governmental authority, or the entry of an order confirming a plan of reorganization, arrangement or liquidation by a court or governmental authority having supervision or jurisdiction over substantially all of the assets or business of the Issuer.

(e) Limitations, Disclaimers, and Amendments. (i) The Issuer shall be obligated to observe and perform the covenants specified in this Section for so long as, but only for so long as, the Issuer remains an "obligated person" with respect to the Series 2014 Bonds within the meaning of the Rule, except that the Issuer in any event will give notice of any deposit made in accordance with this Resolution or applicable law that causes Series 2014 Bonds no longer to be outstanding.

(ii) The provisions of this Section are for the sole benefit of the holders and beneficial owners of the Series 2014 Bonds, and nothing in this Section, express or implied, shall give any benefit or any legal or equitable right, remedy, or claim hereunder to any other person. The Issuer undertakes to provide only the financial information, operating data, financial statements, and notices which it has expressly agreed to provide pursuant to this Section and does not hereby undertake to provide any other information that may be relevant or material to a complete presentation of the Issuer's financial results, condition, or prospects or hereby undertake to update any information provided in accordance with this Section or otherwise, except as expressly provided herein. The Issuer does not make any representation or warranty concerning such information or its usefulness to a decision to invest in or sell Series 2014 Bonds at any future date.

(iii) UNDER NO CIRCUMSTANCES SHALL THE ISSUER BE LIABLE TO THE HOLDER OR BENEFICIAL OWNER OF ANY SERIES 2014 BOND OR ANY OTHER PERSON, IN CONTRACT OR TORT, FOR DAMAGES RESULTING IN WHOLE OR IN PART FROM ANY BREACH BY THE ISSUER, WHETHER NEGLIGENT OR WITHOUT FAULT ON ITS PART, OF ANY COVENANT SPECIFIED IN THIS SECTION, BUT EVERY RIGHT AND REMEDY OF ANY SUCH PERSON, IN CONTRACT OR TORT, FOR OR ON ACCOUNT OF ANY SUCH BREACH SHALL BE LIMITED TO AN ACTION FOR MANDAMUS OR SPECIFIC PERFORMANCE.

(iv) No default by the Issuer in observing or performing its obligations under this Section shall comprise a breach of or default under this Resolution for purposes of any other provision of this Resolution. Nothing in this Section is intended or shall act to disclaim, waive, or otherwise limit the duties of the Issuer under federal and state securities laws.

(v) The provisions of this Section may be amended by the Issuer from time to time to adapt to changed circumstances that arise from a change in legal requirements, a change in law, or a change in the identity, nature, status, or type of operations of the Issuer, but only if (1) the provisions of this Section, as so amended, would have permitted an underwriter to purchase or sell Series 2014 Bonds in the primary offering of the Series 2014 Bonds in compliance with the Rule, taking into account any amendments or interpretations of the Rule since such offering as well as such changed circumstances and (2) either (a) the holders of a majority in aggregate principal amount (or any greater amount required by any other provision of this Resolution that authorizes such an amendment) of the Outstanding Series 2014 Bonds consent to such amendment or (b) a person that

is unaffiliated with the Issuer (such as bond counsel) determines that such amendment will not materially impair the interest of the holders and beneficial owners of the Series 2014 Bonds. If the Issuer so amends the provisions of this Section, it shall include with any amended financial information or operating data next provided in accordance with subsection (a) of this Section an explanation, in narrative form, of the reason for the amendment and of the impact of any change in the type of financial information or operating data so provided. The Issuer may also amend or repeal the provisions of this continuing disclosure agreement if the SEC amends or repeals the applicable provision of the Rule or a court of final jurisdiction enters judgment that such provisions of the Rule are invalid, but only if and to the extent that the provisions of this sentence would not prevent an underwriter from lawfully purchasing or selling Series 2014 Bonds in the primary offering of the Series 2014 Bonds.

Section 31. SALE OF SERIES 2014 BONDS. Pursuant to the authorizations in Section 3 hereof, as approved by the Authorized Officer, the Series 2014 Bonds may be sold either pursuant to the taking of bids therefor as provided in an Official Notice of Sale or pursuant to a purchase agreement (the "Purchase Agreement") with a purchaser or purchasers (collectively, the "Underwriters") to be approved by the Authorized Officer, and any supplements thereto which may be necessary to accomplish the issuance of Bonds. Such Purchase Agreement is hereby authorized to be dated, executed and delivered on behalf of the Issuer by an Authorized Officer, with such changes therein as shall be approved by the Authorized Officer, the execution thereof by the Authorized Officer to constitute evidence of such approval. The delegation of authority to the Authorized Officer to approve the final terms of the Bonds as set forth in this Resolution is, and the decisions made by the Authorized Officer pursuant to such delegated authority will be, in the best interests of the Issuer, and the Authorized Officer is authorized to make a finding to such effect in the Approval Certificate.

Section 32. APPROVAL OF OFFICIAL STATEMENT. A Preliminary Official Statement relating to the Series 2014 Bonds, in substantially the form as submitted to the Board of Directors at this meeting, is hereby approved and authorized to be distributed to prospective investors and other interested parties in connection with the underwriting and sale of the Series 2014 Bonds, with such changes therein as shall be approved by the President of the Board of Directors or the General Manager of the Issuer, including such changes as are necessary for distribution as a final Official Statement. It is further officially found, determined, and declared that the statements and representations contained in said Preliminary Official Statement are true and correct in all material respects. The use and distribution by the Purchaser of the Official Statement relating to the Series 2014 Bonds, is hereby approved. For the purpose of review by the Purchaser prior to purchasing the Series 2014 Bonds, the Issuer deems said Preliminary Official Statement to have been "final as of its date" within the meaning of Securities and Exchange Commission Rule 15c2-12.

Section 33. ATTORNEY GENERAL FEES. The Issuer hereby authorizes and directs payment, from legally available funds of the Issuer, of the nonrefundable examination fee of the Attorney General of the State of Texas required by Section 1202.004, Texas Govemment Code, as amended.

Section 34. FURTHER PROCEDURES. The President and the Secretary of the Board of Directors and the General Manager and the Finance Director of the Issuer, and all other officers,

employees, and agents of the Issuer, and each of them, shall be and they are hereby expressly authorized, empowered, and directed from time to time and at any time to do and perform all such acts and things and to execute, acknowledge, and deliver in the name and on behalf of the Issuer all such instruments, whether or not herein mentioned, as may be necessary or desirable in order to carry out the terms and provisions of this Resolution, and all details in connection therewith. In case any officer whose signature shall appear on any Series 2014 Bond shall cease to be such officer before the delivery of such Series 2014 Bond, such signature shall nevertheless be valid and sufficient for all purposes the same as if such officer had remained in office until such delivery.

Section 35. REPEAL OF CONFLICTING RESOLUTIONS. All resolutions and all parts of any resolutions which are in conflict or inconsistent with this Resolution are hereby repealed and shall be of no further force or effect to the extent of such conflict or inconsistency.

Section 36. PUBLIC NOTICE. It is hereby officially found and determined that public notice of the time, place and purpose of said meeting was given, all as required by the Government Code, Chapter 551.

EXHIBIT "A"

WRITTEN PROCEDURES RELATING TO CONTINUING
COMPLIANCE WITH FEDERAL TAX COVENANTS

A. Arbitrage. With respect to the investment and expenditure of the proceeds of the Series 2014 Bonds and any Additional Bonds (the "Obligations") the Issuer's General Manager, Assistant General Manager, and Director of Finance (the "Responsible Persons") will :

For Obligations issued for newly acquired property or constructed property:

- instruct the appropriate person or persons that the construction, renovation or acquisition of the facilities must proceed with due diligence and that binding contracts for the expenditure of at least 5%of the proceeds of the Obligations will be entered into within 6 months of the Issue Date;

- monitor that at least 85% of the proceeds of the Obligations to be used for the construction, renovation or acquisition of any facilities are expended within 3 years of the date of delivery of the Obligations ("Issue Date");

- restrict the yield of the investments (other than those in the Reserve Fund) to the yield on the Obligations after 3 years of the Issue Date;

- monitor all amounts deposited into a sinking fund or funds, e.g., the Interest and Redemption Fund and the Reserve Fund, to assure that the maximum amount invested at a yield higher than the yield on the Obligations does not exceed an amount equal to the debt service on the Obligations in the succeeding 12 month period plus a carryover amount equal to one-twelfth of the principal and interest payable on the Obligations for the immediately preceding 12-month period;

- assure that no more than 50% of the proceeds of the Obligations are invested in an investment with a guaranteed yield for 4 years or more;

- assure that the maximum amount of the Reserve Fund invested at a yield higher than the yield on the Obligations will not exceed the lesser of (1) 10% of the original principal amount of the Obligations, (2) 125% of the average annual debt service on the Obligations measured as of the Issue Date, or (3) 100% of the maximum annual debt service on the Obligations as of the Issue Date;

For Obligations issued for refunding purposes:

- monitor the actions of the escrow agent (to the extent an escrow is funded with proceeds) to assure compliance with the applicable provisions of the escrow agreement, including with respect to reinvestment of cash balances;

For all Obligations:

- maintain any official action of the Issuer (such as a reimbursement resolution) stating its intent to reimburse itself or the City with the proceeds of the Obligations any amount expended prior to the Issue Date for the acquisition, renovation or construction of the facilities;

- assure that the applicable information return (e.g., IRS Form 8038-G, 8038-GC, or any successor forms) is timely filed with the IRS;

- assure that, unless excepted from rebate and yield restriction under section 148(f) of the Code, excess investment earnings are computed and paid to the U.S. government at such time and in such manner as directed by the IRS (i) at least every 5 years after the Issue Date and (ii) within 30 days after the date the Obligations are retired.

B. Private Business Use. With respect to the use of the facilities financed or refinanced with the proceeds of the Obligations the Responsible Persons will:

- monitor the date on which the facilities are substantially complete and available to be used for the purpose intended;

- monitor whether, at any time the Obligations are outstanding, any person, other than the Issuer or the City, the employees of the Issuer or the City, the agents of the Issuer or the City or members of the general public has any contractual right (such as a lease, purchase, management or other service agreement) with respect to any portion of the facilities;

- monitor whether, at any time the Obligations are outstanding, any person, other than the Issuer or the City, the employees of the Issuer or the City, the agents of the Issuer or the City or members of the general public has a right to use the output of the facilities (e.g., water, gas, electricity);

- monitor whether, at any time the Obligations are outstanding, any person, other than the Issuer or the City, the employees of the Issuer or the City, the agents of the Issuer or the City or members of the general public has a right to use the facilities to conduct or to direct the conduct of research;

- determine whether, at any time the Obligations are outstanding, any person, other than the Issuer or the City, has a naming right for the facilities or any other contractual right granting an intangible benefit;

- determine whether, at any time the Obligations are outstanding, the facilities are sold or otherwise disposed of; and

- take such action as is necessary to remediate any failure to maintain compliance with the covenants contained in the resolution authorizing the Obligations.

C. Record Retention. The Responsible Persons will maintain or cause to be maintained all records relating to the investment and expenditure of the proceeds of the Obligations and the use of the facilities financed or refinanced thereby for a period ending three (3) years after the complete extinguishment of the Obligations. If any portion of the

Obligations is refunded with the proceeds of another series of tax-exempt obligations, such records shall be maintained until the three (3) years after the refunding obligations are completely extinguished. Such records can be maintained in paper or electronic format.

D. Responsible Persons. Each Responsible Person shall receive appropriate training regarding the Issuer's accounting system, contract intake system, facilities management and other systems necessary to track the investment and expenditure of the proceeds and the use of the facilities financed with the proceeds of the Obligations. The foregoing notwithstanding, the Responsible Persons are authorized and instructed to retain such experienced advisors and agents as may be necessary to carry out the purposes of these instructions.

EXHIBIT "B"

DESCRIPTION OF ANNUAL FINANCIAL INFORMATION

The following information is referred to in Section 30 of this Resolution.

I. Annual Financial Statements and Operating Data of the Issuer

The financial information and operating data with respect to the Issuer to be provided annually in accordance with such Section are as specified (and included in the Appendix or under the headings of the Official Statement and Tables referred to) below:

Tables 1 through 9 in the Official Statement and in Appendix B

Accounting Principles

The accounting principles referred to in such Section are the accounting principles described in the notes to the financial statements referred to in paragraph 1 above.

THIS DOCUMENT WAS ORIGINALLY APPROVED BY THE TRWD BOARD OF DIRECTORS ON MAY 20, 2014.

TARRANT REGIONAL WATER DISTRICT

WATER CONSERVATION AND DROUGHT CONTINGENCY PLAN

MAY 2014

David Marshall, P.E.

Linda Christie, J.D.

Tarrant Regional Water District
800 East Northside Drive
Fort Worth, TX 76102
817/335-2491

ACKNOWLEDGEMENTS

Tarrant Regional Water District (TRWD) has modified this plan to maintain a consistent and regional approach to water conservation and drought response strategies. Certain sections of the plan were customized to meet the needs of TRWD customers. The plan was prepared pursuant to Texas Commission on Environmental Quality rules. Some material is based on the existing water conservation plans listed in Appendix A. Conservation and emergency water management (drought contingency) plans for the City of Fort Worth and the City of Dallas were used extensively.

Questions regarding this water conservation and drought contingency plan should be addressed to the following:

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TARRANT REGIONALWATER DISTRICT

Water Conservation and Drought Contingency Plan

MAY 2014

1. INTRODUCTION AND OBJECTIVES

The water supplies we depend on are not endless resources. For one thing, drought conditions are a part of life here in North Texas. Droughts are unpredictable but they have a direct impact on our water resources. Without rainfall and runoff the reservoirs we rely on to meet our needs are depleted faster than they are replenished. In addition, the number of people living in our region is expected to double in the next 50 years. That means the demand for water will certainly rise – and meeting that demand will be a challenge.

In recent years, the growing population and economic development in North Texas has led to an increase in demands for water supplies. At the same time, local and less expensive sources of water supply are largely developed. In planning and developing new water supplies, water conservation strategies will play a vital role in meeting TRWD's projected water needs. The 2012 State Water Plan reports that 12 percent of future water needs in Region C will be met through municipal conservation.[1] From a cost standpoint, water conservation is the most cost-effective alternative for meeting new water demands. Therefore it is important that we use the water we already have more efficiently.

Over time, conserving water on a daily basis:

- extends the life of existing supplies to meet new water demands
- slows the drain on reservoirs making more water available during times of drought
- reduces peak supply requirements, which reduces wear and tear on existing infrastructure
- defers increases in capital and operating costs for existing systems, and
- delays the need for developing expensive, new water supplies.

Recognizing the need for efficient use of existing water supplies, the Texas Commission on Environmental Quality (TCEQ) has issued guidelines and requirements governing the development of water conservation and drought contingency plans for wholesale water suppliers.[1, 2] TCEQ guidelines and requirements for wholesale suppliers are included in Appendix B. The best management practices published by the Water Conservation Implementation Task Force[3], and established pursuant to SB1094 by the 78th Legislature, were also considered in the development of water conservation measures.

TRWD is a regional wholesale public water supplier serving four primary customers including the cities of Arlington, Fort Worth, Mansfield and the Trinity River Authority and numerous other customers across eleven counties. The service area includes Jack, Wise, Denton, Parker, Tarrant, Johnson, Ellis, Kaufman, Henderson, Navarro and Freestone counties. The Water District currently provides water to more than 1.8 million people. This plan replaces the plan dated April 2009.

The water conservation sections of this plan include measures that are intended to result in ongoing, long-term water savings. The TRWD drought contingency and water emergency response sections of this plan address strategies designed to temporarily reduce water use in response to specific conditions.

The objectives of this water management plan are as follows:

- To reduce water consumption from the levels that would prevail without conservation efforts.
- To reduce the loss and waste of water.
- To improve efficiency in the use of water.
- To document the level of recycling and reuse in the water supply.
- To extend the life of current water supplies by reducing the rate of growth in demand.

This plan includes all the elements required by TCEQ. Some elements go beyond TCEQ requirements. Customers of TRWD wishing to adjust elements of their individual plan should coordinate with TRWD. The final adopted versions of customer water conservation and drought contingency plans including appendices, rules, resolutions and ordinances should be provided to TRWD, as well as TCEQ and the Texas Water Development Board (TWDB).

There are additional water saving measures not specifically mentioned in the plan. TRWD urges all water users to implement the highest level of water saving measures that are feasible. It also encourages all commercial and industrial entities to further their conservation and reuse efforts to the maximum extent practicable.

2. TEXAS COMMISSION ON ENVIRONMENTAL QUALITY RULES

2.1 Conservation Plans

The TCEQ rules governing development of water conservation plans for wholesale water suppliers are contained in Title 30, Part 1, Chapter 288, Subchapter A, Rule 288.5 of the Texas Administrative Code, which is included in Appendix B. For the purpose of these rules, a water conservation plan is defined as "A strategy or combination of strategies for reducing the volume of water withdrawn from a water supply source, for reducing the loss or waste of water, for maintaining or improving the efficiency in the use of water, for increasing the recycling and reuse of water, and for preventing the pollution of water. A water conservation plan may be a separate document identified as such or may be contained within another water management document(s)." [1] The elements in the TCEQ water conservation rules covered in this conservation plan are listed below.

Minimum Conservation Plan Requirements for Wholesale Water Suppliers

TRWD is a wholesale water supplier to cities and other customers in North Central Texas. In addition to municipalities, TRWD serves utility districts, water supply corporations, and smaller entities, such as schools and golf courses. The minimum requirements in the Texas Administrative Code for water conservation plans for wholesale water suppliers are covered in this report as follows:

- 288.5(1)(A) – Description of Service Area – Section 3 and Appendix C
- 288.5(1)(B) – Specific, Quantified Five and Ten year Goals – Section 4
- 288.5(1)(C) – Measure and Account Water Diverted – Section 5.1
- 288.5(1)(D) – Monitoring and Record Management System – Sections 5.2 and 7.4
- 288.5(1)(E) – Program of Metering and Leak Detection and Repair – Section 5.3
- 288.5(1)(F) – Requirement for Water Conservation Plans by Wholesale Customers – Section 6.1
- 288.5(1)(G) – Reservoir System Operation Plan – Section 6.2
- 288.5(1)(H) – Means of Implementation and Enforcement – Section 9
- 288.5(1)(I) – Documentation of Coordination with Regional Water Planning Groups – Section 6.3
- 288.5(3) – Review and Update of Plan – Section 10

Additional Conservation Strategies

The Texas Administrative Code lists additional water conservation strategies that can be adopted by a wholesale supplier but are not required. Additional strategies adopted by Tarrant Regional Water District include the following:

- 288.5(2)(B) – Program to Assist Customers – Section 7

- 288.5(2)(C) – Program for Reuse and/or Recycling – Section 8.1
- 288.5(2)(D) – Other measures – Sections 8.2 (public education) and 8.3 (in-house conservation measures)

2.2 Drought Contingency Plans

The TCEQ rules governing development of drought contingency plans for wholesale water suppliers are contained in Title 30, Part 1, Chapter 288, Subchapter B, Rule 288.22 of the Texas Administrative Code, which is included in Appendix B.

For the purpose of these rules, a drought contingency plan is defined as "a strategy or combination of strategies for temporary supply and demand management responses to temporary and potentially recurring water supply shortages and other water supply emergencies. A drought contingency plan may be a separate document identified as such or may be contained within another water management document(s)." [2] The drought contingency plan for TRWD is contained in Section 11 of this water management plan.

3. DESCRIPTION OF TRWD SERVICE AREA

The Tarrant Regional Water District (TRWD) was established in 1924 as a political subdivision of the State of Texas. It has two primary missions: to provide our region with water and flood control.

The Water District is a regional wholesale water supplier located in North Central Texas. It provides untreated surface water to four primary customers in Tarrant County. They include the cities of Arlington, Fort Worth and Mansfield, and the Trinity River Authority (TRA). TRWD also provides water to some smaller utilities and other water user groups located near its reservoirs.

In addition to providing their own citizens with clean drinking water, Fort Worth, Mansfield and TRA supply neighboring municipalities and/or utility districts with treated water and wastewater services. Tables 3.1 through 3.3 list TRWD's customers (direct and indirect). An indirect customer refers to any successive wholesale customers of TRWD's primary customers.

The Water District has a total service population of approximately 1.8 million. It is ultimately responsible for serving 68 cities across an 11-county area. However, several of those cities are not currently taking water. Figure 3.1 shows the TRWD service area and supply system, which covers 5,891 square miles in Jack, Wise, Denton, Parker, Tarrant, Johnson, Ellis, Kaufman, Henderson, Navarro and Freestone counties. All but one of these counties is located within the Region C Water Planning Group – one of 16 water planning groups established by the Texas Water Development Board (TWDB) to develop and revise comprehensive water plans for the state. Johnson County is part of the Region G Water Planning Group.

TRWD uses a system of reservoirs to meet the water needs of its customers. Most of its raw water supplies originate from reservoirs constructed and managed by the Water District. They include Lake Bridgeport, Eagle Mountain Lake, Cedar Creek and Richland-Chambers Reservoirs. Two smaller reservoirs in Tarrant County – Lakes Benbrook and Arlington – are used for terminal storage. The total permitted supply currently available to TRWD is 773,100 acre-feet. However, the firm yield of the reservoir system is lower and stands at 533,833 acre-feet. These totals include 63,000 acre-feet from an indirect reuse project at Richland-Chambers Reservoir. The George W. Shannon Wetlands Water Recycling Facility began operation in October 2013. A future reuse project at Cedar Creek Reservoir will add 52,500 acre-feet to the system's supply. Additional information on TRWD's reuse and recycling efforts can be found in Section 8.1.

The Water District uses pump stations and approximately 184 miles of pipelines to transport water into Tarrant County from Cedar Creek and Richland-Chambers reservoirs in East Texas. Total pumping capacity from the eastern division reservoirs is 377 million gallons per day (MGD). The water from Lake Bridgeport and Eagle Mountain Lake on the West Fork of the Trinity River is gravity fed into Lake Worth.

Further details of TRWD's reservoir operations can be found in Section 6.2. Appendix C to the water conservation and drought contingency plans contains a profile for wholesale public water suppliers for TRWD, based on the format recommended by the TCEQ. Table 3.4 summarizes key facts from the wholesale supplier profile.

Table 3.1

TRWD Customers served by Eastern Division Reservoirs including Lake Benbrook, Cedar Creek Reservoir, and Richland-Chambers Reservoir

Lake Benbrook
Benbrook Water Authority
City of Weatherford
Fort Worth Country Day School (Irr.)
Mira Vista Golf Club (Irr.)
Ridglea Country Club (Irr.)
Whitestone Golf Club (Irr.)
Indirect Customers:
City of Hudson Oaks
Parker County Special Utility District
Parker County Utility District

Cedar Creek Reservoir
Bill Sisul/Shady Oaks Golf (Irr.)
Cedar Creek Country Club (Irr.)
City of Kemp
City of Mabank
City of Malakoff
City of Midlothian
City of Star Harbor
City of Trinidad
East Cedar Creek Freshwater Supply District
Exelon (Ind.)
Golf Driving Range
Long Cove Ranch (Irr.)
Monarch Utilities
Pinnacle Country Club (Irr.)
Post Oak Ranch (Irr.)
Tristream East Tx (Ind.)
West Cedar Creek MUD
Indirect Customers:
City of Payne Springs

Cedar Creek Reservoir (continued)
City of Seven Points
City of Tool
Richland-Chambers Reservoir
Freestone (Ind.)
City of Corsicana
City of Fairfield
Winkler Water Supply

Table 3.2

TRWD Customers served by Western Division Reservoirs, including Lake Bridgeport and Eagle Mountain Lake

Lake Bridgeport
Brazos Electric Power Company (Ind.)
City of Bridgeport
City of Jacksboro
City of Runaway Bay
Hanson Aggregates (Ind.)
Martin Marietta (Ind.)
Runaway Bay Golf Club (Irr.)
Suez/Wise County Power (Ind.)
Walnut Creek Special Utility District
West Wise Rural Water Supply Corp.
Wise County Water Supply District (Decatur)
Indirect Customers:
City of Boyd
City of Decatur
City of Newark
City of Paradise
City of Reno
City of Rhome

Eagle Mountain Lake
City of Azle
City of River Oaks
City of Springtown
Community Water Supply
Hawk's Creek Golf Club (Irr.)
Shady Oaks Country Club (Irr.)
Trinity Materials (Ind.)
TXU Eagle Mountain Plant (Ind.)

Table 3.3

Wholesale Water Customers Served by TRWD's Primary Customers: the cities of Arlington, Fort Worth, Mansfield and the Trinity River Authority

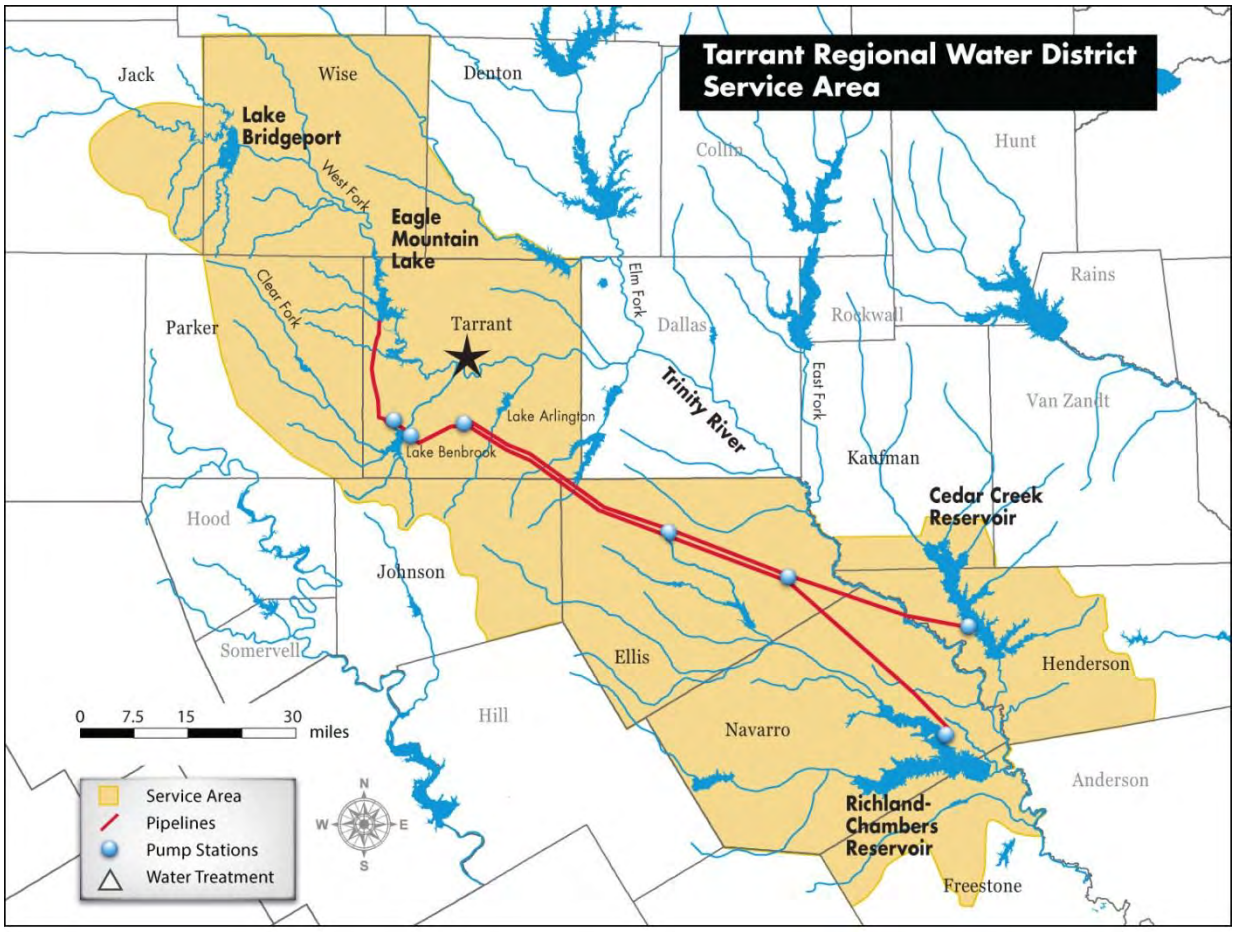
Arlington:	
City of Grand Prairie	
Fort Worth (List includes current and future customers)	
City of Aledo	City of Northlake
Bethesda Water Supply Corporation	City of North Richland Hills
City of Burleson	City of Richland Hills
City of Crowley	City of Roanoke
City of Dalworthington Gardens	City of Saginaw
City of Edgecliff Village	City of Sansom Park Village
City of Everman	City of Southlake
City of Forest Hill	City of Watauga
City of Grand Prairie	City of Westlake
City of Haltom City	City of Westover Hills
City of Haslet	City of Westworth Village
City of Hurst	City of White Settlement
City of Keller	Dallas-Fort Worth International Airport
City of Kennedale	Trinity River Authority
City of Lake Worth	Trophy Club Municipal Utility District

Mansfield	
City of Grand Prairie	
Johnson County Special Utility District	

Trinity River Authority	
<u>Cities served through Tarrant County Water Supply Project:</u> City of Bedford City of Colleyville City of Euless City of Grapevine City of North Richland Hills <u>Cities served by direct contract:</u> City of Ennis City of Midlothian <u>Cities and entities served under the Ellis County contract:</u> Avalon Water and Sewer Service Corporation	Buena Vista-Bethel Special Utility District City of Ferris City of Italy City of Maypearl City of Midlothian City of Palmer City of Red Oak Ellis County Water Control and Improvement District (City of Waxahachie) Nash-Forreston Water Supply Corporation Rockett Special Utility District <u>Indirect Customers:</u> City of Venus

Figure 3-1

Tarrant Regional Water District Service Area and Supply System Map



Summary of Wholesale Public Water Supplier Profile for Tarrant Regional Water District

Water District Service Area:	5,891 square miles
Water Supply Sources (Year Impounded):	Lake Bridgeport (1931) Eagle Mountain Lake (1932) Lake Benbrook (1952) Cedar Creek Reservoir (1965) Richland-Chambers Reservoir (1987)
Distribution System:	Cedar Creek Pipeline: Year completed: 1971 Length: 75 miles Diameter: 72-inches Maximum capacity: 127 mgd Richland-Chambers Pipeline Year completed: 1989 Length: 78 miles Diameter: 90-inches Maximum capacity: 249 mgd Benbrook Pipeline: Year completed: 1998 Length: 11 miles Diameter: 90-inches Eagle Mountain Pipeline: Year completed: 2008 Length: 20 miles Diameter: 90 and 84-inches Eleven Pump Stations: Cedar Creek, Richland-Chambers, Ennis (2), Waxahachie (2), Lake Benbrook (2), Rolling Hills Drinking Water Treatment Plant, Richland-Chambers Wetlands Water Reuse Project (2)
Population (2009 plan): Estimated Population in 2008: Projected Population in 2050:	 1,733,983 3,322,927
Population (2014 plan): Estimated Population in 2013: Estimated Population in 2060::	 1,817,900 4,287,600

Total Water Diversions for all Water Uses (in acre-feet) 2000 – 2013:		
Year	Volume	Population Served
2000	393,910	1,440,342
2001	394,318	1,473,172
2002	356,140	1,505,912
2003	428,734	1,538,652
2004	355,866	1,587,452
2005	523,482	1,622,908
2006	473,527	1,659,137
2007	355,900	1,696,157
2008	441,114	1,733,983
2009	340,596	1,796,405
2010	352,854	1,771,443
2011	404,402	1,781,735
2012	369,243	1,795,707
2013	356,240	1,817,900

4. SPECIFICATION OF WATER CONSERVATION GOALS

TCEQ rules require the adoption of specific water conservation goals to be included in this water conservation plan. The goals must include five and ten year targets for water savings, including, where appropriate, target goals for municipal use in gallons per capita per day across the Water District service area. However, as a wholesale water supplier, TRWD does not directly control the water use of its customers nor does it have a direct relationship with the retail customers who are the ultimate consumers of the water.

Many of TRWD's municipal customers are projected to have increasing per capita demands in the future.[4] The reasons for these projected increases include the following:

- The transformation of portions of the TRWD service area from historically rural to primarily suburban areas.
- Rapid population growth, which has historically been associated with increasing per capita municipal water use in North Texas.
- The influx of commercial development, changes in housing types, and growth in employment associated with urbanization.

The municipal per capita use for TRWD's system can be affected by changes in per capita use of its customers. It can also be affected by how much water TRWD is asked to supply to high per capita use customers versus low per capita use customers. These factors and others, such as increases in industrial or commercial usage and municipal water losses, cannot be controlled by TRWD.

TRWD does control the operation of its water supply and delivery system and can take direct action to maximize the efficiency of that system. In areas under its direct control, TRWD adopts the following goals for water conservation and efficiency:

- Keep the level of unaccounted water in the system below 5%, as discussed in Section 5.2.
- Maintain universal metering of customers, meter calibration, and meter replacement and repair, as discussed in Section 5.2.
- Maintain a program of leak detection and repair, as discussed on Section 5.3.
- Begin to utilize indirect reuse as a major source of water supply, as discussed in Section 8.1.
- Continue to implement in-house water conservation efforts, as discussed in Section 8.4.
- Raise public awareness of water conservation and encourage responsible public behavior by a public education program, as discussed in Section 8.2.

As a wholesale provider, TRWD will assist its customers in the development of water conservation programs. TRWD has developed a *Model Water Conservation Plan for*

TRWD Customers and a *Model Drought Contingency Plan for TRWD Customers* that its customers can use to develop their own water conservation and drought contingency plans.

As part of the model water conservation plan, TRWD requires water utility customers to provide annual water conservation reports, modeled after the Utility Profile developed by TCEQ. A copy of the report is included in Appendix F. TRWD will review these reports and compile the information as part of its own annual conservation report, which will be used to manage TRWD's water conservation program.

In calculating target goals for per capita water savings among its municipal users, TRWD focused on water use among its four primary customers in Tarrant County. The cities of Arlington, Fort Worth, Mansfield and the Trinity River Authority and their successive customers (listed in Table 3.2) receive an average of 90 to 92 percent of all TRWD water deliveries. Table 4.1 summarizes annual water use for these customers from 2003 – 2013. The data shown in the table reflect the following:

- Population estimates (Table 4.2) are based on information provided by the North Central Texas Council of Governments (NCTCOG). The art of estimating population is by no means an exact science. The NCTCOG methodology for determining population is based on building permits, occupancy factors and household size factors. The figures are reviewed at a regional level for consistency with other indicators of regional population such as labor force estimates and vital statistics.[5]
- Populations of some TRA customers were adjusted to reflect the percentage of water needs it meets within those cities, (Grapevine: 52 percent; North Richland Hills: 37 percent). Populations were also adjusted for communities that rely on groundwater to supplement water supplies, (Bedford: 85 percent; Colleyville: 93 percent; Euless: 76 percent).
- The Water District serves approximately 98 percent of Tarrant County. Its four primary customers and the customers they serve represent approximately 92 percent of the total Tarrant County population.
- The gallons per capita per day (gpcd) figures represent all water uses among our primary customers and are calculated by dividing total amount of water diverted and/or pumped for potable use by total population.[6] Water use categories include residential, commercial, institutional, and industrial, as well as process-related and municipal system water losses.
- Industrial use varies by community and represents approximately three percent of Arlington's water use, three percent of Mansfield's water use, and nine percent of Fort Worth's water use.
- Rainfall data recorded at DFW International Airport is also included to show the correlation between water use and precipitation. Higher water use is usually observed during periods of below average rainfall. This is predominantly due to an increase in the amount of water used for irrigation.

Table 4.1

Water Use among TRWD's Primary Customers and their Successive Customers 2003-2013, including Rainfall, Total Water Supplied, Estimated Population, and Total Municipal Gallons per Capita per Day

Year	Rainfall at DFW Airport (inches)	Total Water Supplied to Primary Customers	Estimated Population of Primary customers (including wholesale)	Total Municipal Gallons per Capita per Day
2003	24.55	301,061	1,445,291	185.4
2004	47.57	282,700	1,484,637	169.6
2005	18.97	344,596	1,523,983	201.2
2006	29.75	362,091	1,563,329	206.2
2007	50.05	284,343	1,597,425	158.5
2008	27.10	337,192	1,630,603	184.4
2009	40.89	306,686	1,663,338	164.6
2010	31.70	321,087	1,640,225	174.8
2011	25.88	364,846	1,649,755	197.4
2012	31.26	333,289	1,662,692	179.0
2013	29.40	308,400	1,683,241	163.6
Current 5-Year Average Per Capita Municipal Use among TRWD's Primary Customers without Credit for Reuse.				175.9

Total municipal gpcd = [(total acre-feet supplied x 325,851 gallons/acre-foot) / population] / 365 days per year]

Average gpcd with reuse taken into account for 2013 was 157.8.

Table 4.2

Estimated Population Served by TRWD's Primary Customers and their Successive Customers 2003-2013 based on data from the North Central Texas Council of Governments

Year	Arlington	Fort Worth	Mansfield	Trinity River Authority
2003	348,260	898,946	38,391	159,695
2004	353,356	927,430	41,844	162,007
2005	358,453	955,913	45,297	164,320
2006	363,550	984,397	48,750	166,632
2007	364,300	1,012,880	51,300	168,945
2008	369,150	1,034,958	54,618	171,877
2009	370,450	1,062,306	57,601	172,981
2010	365,438	1,042,160	56,368	176,260
2011	365,530	1,050,935	56,840	176,449
2012	365,860	1,062,299	57,490	177,043
2013	369,320	1,077,020	58,490	178,410
Percent increase 2004-2008	4.47%	11.59%	30.53%	6.09%
Percent increase 2009-2013	-0.31%	1.39%	1.54%	3.14%

In a special report to the 79th Legislature, the TWDB recommends a minimum annual reduction of one percent total gpcd, based upon a five-year rolling average until at such time as the entity achieves a total gpcd of 140 or less.[7] Table 4.3 shows projected municipal per capita water use for TRWD. The per capita use does not include the effect of new water conservation measures that may be adopted by TRWD customers. Table 4.3 also includes TRWD's targets for reduction to municipal per capita use due to the implementation of this water conservation and drought contingency plan and the plans to be developed by its customers. The information shown on the table reflects the following:

- The target for the five-year (2018) municipal per capita water use for TRWD's primary customers and their successive customers is 166 gallons per capita per day in an average climatic year, as shown in Table 4.3. This represents a five percent reduction of almost nine gallons per capita per day.
- The target for the ten-year (2023) municipal per capita water use for TRWD's primary customers and their successive customers is 158 gallons per capita per

day in an average climatic year, as shown in Table 4.3. This represents a decrease of 17 gallons per capita per day, or approximately ten percent.

- Projected total per capita water use figures are based on an average climate conditions. Per capita water use in years with less precipitation, especially during the summer, may be more than projected here.
- Indirect reuse diversion volumes shall be credited against total diversion volumes for the purpose of calculating gpcd for targets and goals.[7] The Water District estimates that over the next five years approximately 10 percent of its water supplies will be derived from indirect reuse. Credit for reuse is included in the five and ten year per capita goals.

Table 4.3

Five-Year and Ten-Year Municipal Per Capita Water Use Goals for TRWD's Primary Customers and their Successive Customers (Total GPCD)

Description	Year	Target Per capita	Per capita with Reuse
Current 5-Year Average Per Capita Municipal Use Among TRWD's Primary Customers	2004 – 2008	184	
5-Year Goal (5% reduction with credit for reuse)	2013	175	174.7
New 5-Year Goal (5% reduction with credit for reuse)	2018	166	
10-Year Goal (5% reduction with credit for reuse)	2023	158	

Additional verification of annual water savings can be found in an annual demand model of TRWD water use developed for the Strategic Water Conservation Plan. The model was calibrated using water demands among the district's primary customers from 1997 to 2004, before water conservation measures were put in place. The model is used to predict TRWD annual demands without conservation and allows for a comparison with actual demands. The difference between the model's projected demands and actual consumption is assumed to be savings.

Here are some highlights of the savings achieved from ongoing conservation efforts from 2007 through 2013:

- A cumulative savings of 104.7 billion gallons or 321,400 acre-feet.
- Annual savings ranging from 8.0 to 32.4 billion gallons, with savings on an annual basis averaging 15.0 billion gallons.

- An average savings of approximately 41.0 mgd. At the 2013 rolling average consumption rate (175.9 gpcd without reuse), 33.0 mgd could supply an additional 233,000 people annually.
- An average savings of almost 46,000 acre-feet per year.

The estimated savings among the district's primary customers in 2013 alone was nearly 100,000 acre-feet – which represents the average amount of water the District supplies from its Western Division reservoirs each year.. A chart illustrating the projected water demands versus actual demands and a table of the estimated annual savings is included below.

Figure 4-1

Estimated Consumption without Conservation vs. Actual Consumption

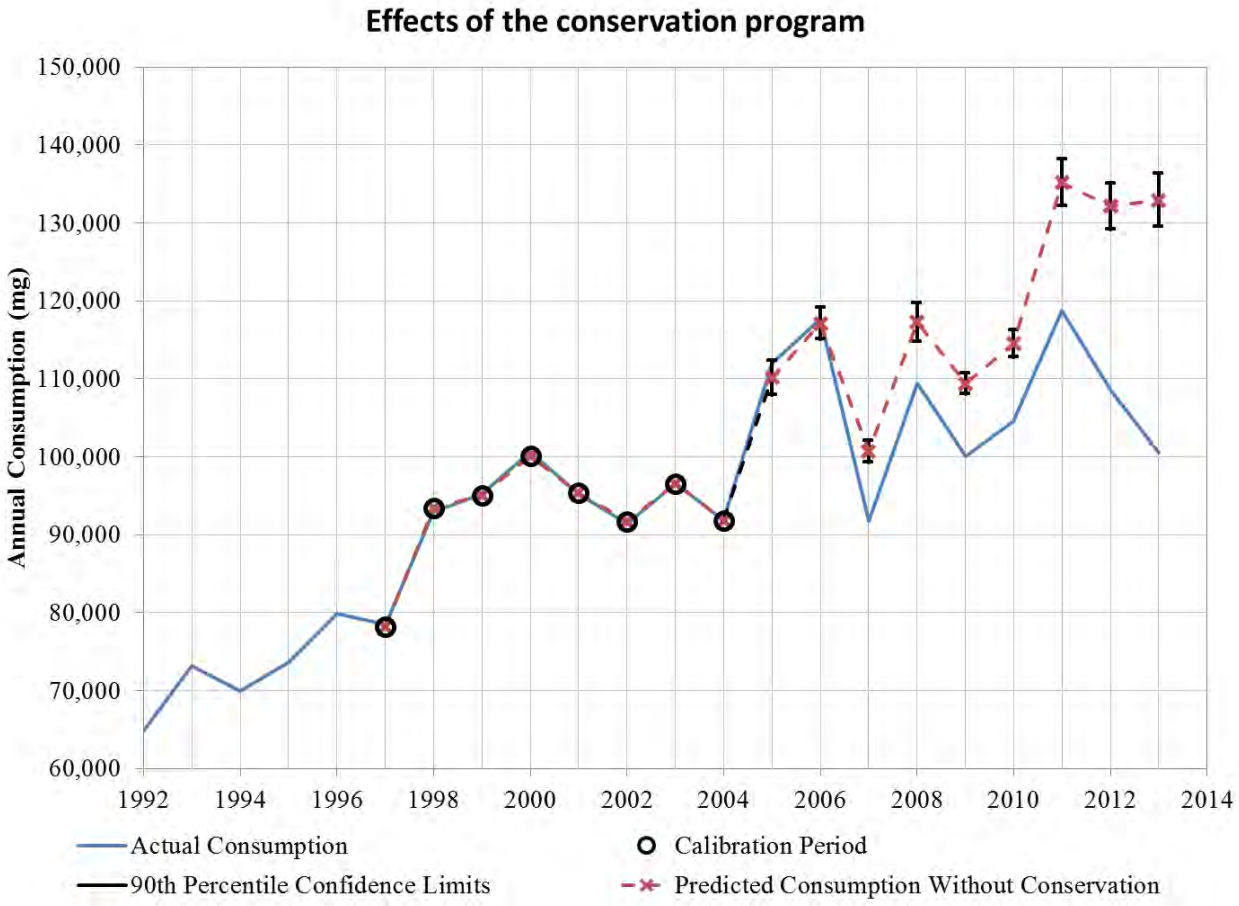


Table 4.4

Estimated Annual Savings Due to Ongoing Water Conservation Efforts and Drought Contingency Measures, 2007-2013

Year	Billion Gallons	Acre-Feet
2007	8.97	27,534
2008	7.95	24,395
2009	9.44	28,979
2010	9.65	29,612
2011	14.43	44,269
2012	21.86	67,070
2013	32.43	99,541
Total Savings	**104.72**	**321,400**

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5. METERING, WATER USE RECORDS, CONTROL OF UNACCOUNTED WATER, AND LEAK DETECTION AND REPAIR

One of the key elements in water conservation is careful tracking of water use and control of losses. Accurate metering of water deliveries and detection and repair of leaks in the raw water delivery system are important elements of TRWD's program to control losses.

5.1 Practices to Measure and Account for the Amount of Water Diverted

TRWD uses two different methods to measure raw water diversions from its reservoirs. Releases from Lake Bridgeport and Eagle Mountain Lake are determined using 48-inch diameter gate valves. Each valve is calibrated so that the volumetric flow rate can be calculated based the size of the gate opening. The Water District meters its raw water diversions from Cedar Creek and Richland-Chambers Reservoirs by meters with accuracy ±5%. The master meters are calibrated semi-annually and repaired or replaced as needed.

5.2 Monitoring and Record Management Program for Determining Deliveries, Sales, and Losses

As a wholesale water supplier, TRWD has instituted a monitoring and record management program to assure that its customers are charged appropriately for their water use. The program includes the following elements:

- Customers with annual demands less than 7,500 acre-feet are required to document their usage in a monthly raw water report. The report includes initiation dates, usage dates, customer name changes and meter status changes.
- TRWD performs scheduled and random readings of customer meters; with no less than three readings taken during a three-month period and a fourth quarter reading taken between September 20 and October 10. In addition, one random reading is performed annually between June 1st and September 30th.
- All meters are documented and the serial number is verified and recorded at each reading.
- Customers with a demand of 7,500 acre-feet or more must provide TRWD with a daily usage total and a monthly reconciliation of usage. Usage volumes are monitored and recorded daily. They are also verified monthly and annually.
- Customers are required to provide, operate, maintain, and read meters. By contract meters must have an accuracy ±5%. TRWD can access the meters at all reasonable times and, upon written request, can have the meters calibrated once per month. In the event a meter is not functioning properly, the customer is required to install a new meter or repair it within 180 days.
- The Water District has the authority to replace or repair any meter.

- Methods to verify water deliveries include calibration tests, mathematical calculations, and estimations based on historical meter data under similar conditions.
- Inaccurate meters at Lake Benbrook and Arlington discharge outlets were replaced in 2008. An additional full insertion probe meter was installed at the Benbrook discharge facility in 2014 to more accurately meter flows.
- TRWD reconciles the water deliveries and reservoir diversions into daily mass balances. All of the Water District's reservoir levels and local precipitation are monitored from USGS recording stations. Measured pan evaporations performed by the USACE are also recorded daily and utilized in conjunction with the TWDB's evaporation coefficients. Using all of the above data, daily mass balances of each reservoir are performed to calculate natural inflows.

One of the goals of TRWD's water conservation program is to maintain unaccounted water below five percent in every year.

5.3 Metering and Leak Detection and Repair

TRWD metering program for raw water is described in Sections 5.1 and 5.2. The following information details the Water District's program to control, detect and repair leaks of its pipeline system:

- All TRWD water transmission pipelines are reinforced concrete cylinder pipe or steel cylinder pipe with an internal protective liner and an external protective coating. Because of the multiple layers of material, these pipelines have very long service lives and are not subject to frequent development of leaks.
- Most joints in TRWD pipelines are designed with bell and spigot joint construction including rubber gasket. Some joints are welded. For larger lines, each joint is also sealed with concrete.
- All TRWD water pipelines are constructed in legally defined and identified rights-of-way, properly registered with authorities in each county.
- TRWD personnel routinely inspect Water District pumping equipment, facilities, and pipelines for leaks or mechanical problems. Aerial surveillance combined with ground observation is used to regularly inspect pipeline routes for breaks and leaks. Repairs are undertaken as soon as practicable in order to minimize waste.
- TRWD conducts annual inspections of sections of the Cedar Creek and Richland-Chambers pipelines using an advanced technology to assess the condition of pipe segments. The method, which uses remote field eddy current transformer coupling technology (RFEC/TC), is a non-destructive way of detecting broken wires in pre-stressed concrete pipe. The analysis is cost-effective and highly accurate, which allows the Water District to target individual pipe segments for replacement. Pipeline repairs are conducted during the winter when demands are typically at their lowest.

- In the summer 2004, TRWD employed the Pressure Pipe Inspection Company's Sahara Leak Detection Technology to inspect a ten-mile section of the Richland-Chambers pipeline where a number of wet areas were observed. No leaks were found and shallow groundwater appears to have been the source of the water-logged soil.
- TRWD operates a program for right-of-way identification for construction projects adjacent to Water District facilities and pipelines in order to minimize leaks caused by pipeline damage during construction
- In 2010, TRWD began conducting annual water loss audits of its pipeline system using AWWA's Water Loss Control Committee's Free Water Audit Software v4.2. The program compares total pumped volumes to billed metered diversions. To date, the pipeline water delivery system has achieved a score of 100 of 100 in each of the audits conducted. The results indicate, TRWD losses do not exceed an accepted standard of meter error of five percent.

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6. OTHER REQUIRED MEASURES

6.1 Requirement for Water Conservation Plans by Wholesale Customers

Every contract for the wholesale sale of water by TRWD entered into, renewed, or extended does include a requirement that the wholesale customer and any wholesale customers of that wholesale customer develop and implement a water conservation plan meeting the requirements of Title 30, Part 1, Chapter 288, Subchapter A, Rule 288.2 of the Texas Administrative Code. This requirement will extend to each successive wholesale customer in the resale of water. TRWD will provide the model water conservation and drought contingency plans described in Section 7.2 to all wholesale customers to assist them in developing their own water conservation and drought contingency plans.

6.2 Reservoir System Operation

TRWD currently has a permitted water supply from the following sources:

Lake Bridgeport (local)	15,000 acre-feet per year
Lake Bridgeport (downstream releases)	78,000 acre-feet per year
Eagle Mountain Lake	159,600 acre-feet per year
Cedar Creek Reservoir	175,000 acre-feet per year
Richland-Chambers Reservoir	210,000 acre-feet per year
Lake Benbrook	72,500 acre-feet per year
Reuse – Richland-Chambers*	63,000 acre-feet per year
Reuse – Cedar Creek*	52,500 acre-feet per year

*The Cedar Creek indirect reuse project represents future water supplies. A schedule for developing a water recycling facility at Cedar Creek Reservoir has not yet been determined. The indirect reuse project at Richland-Chambers Reservoir has been expanded and became fully functional in Fall 2013.

Permitted water supply does not reflect the amount of water TRWD can safely deliver to its customers without adversely affecting the watersheds from which the supplies originate. The following list of sources depicts the firm yield capacities of TRWD's reservoir system. Firm yield of a reservoir is typically defined as the maximum yield that could be delivered without failure during the historical drought of record.

Western Division reservoirs (includes Lake Bridgeport and Eagle Mountain Lake)	79,000 acre-feet per year
Cedar Creek Reservoir	175,000 acre-feet per year
Richland-Chambers Reservoir	210,000 acre-feet per year
Lake Benbrook	6,833 acre-feet per year
Reuse – Richland-Chambers	63,000 acre-feet per year
TOTAL	**533,833 acre feet per year**

TRWD's water supply network includes seven major reservoirs – Lake Bridgeport, Eagle Mountain Lake, Lake Worth, Cedar Creek Reservoir, Richland-Chambers Reservoir, Lake Arlington and Lake Benbrook. The Water District's reservoir system operation plan for its various sources of supply seeks to maximize efficiency of water withdraws within the constraints of existing water rights. Other priorities include maintaining water quality and minimizing potential impacts on recreational users, fish, and wildlife. Each reservoir is operated on a policy of flood release above the conservation elevation. Due to the geographic locations of the reservoirs, TRWD's operations are essentially split into two divisions.

Lake Bridgeport, Eagle Mountain Lake and Lake Worth comprise the Western Division. Each reservoir is situated on the West Fork of the Trinity River. Lake Bridgeport is located in Wise and Jack counties; Eagle Mountain Lake sits downstream in northwest Tarrant County; and Lake Worth is further downstream in Tarrant County. In addition to water supply, each of these reservoirs is used to regulate floodwaters on the West Fork.

The Water District may divert 93,000 acre-feet per year from Lake Bridgeport, of which, 78,000 acre-feet per year may be released downstream into Eagle Mountain Lake. TRWD may divert a maximum of 159,600 acre-feet per year from Eagle Mountain, but that total also includes water released from Lake Bridgeport into Eagle Mountain Lake. The estimated firm yield of the Western Division reservoirs is 79,000 acre-feet per year.

Water is gravity fed from Lake Bridgeport to Eagle Mountain and from Eagle Mountain to Lake Worth to water treatment plants in the city of Fort Worth and neighboring cities and industries. The Water District's operation of the West Fork seeks to maintain Lake Worth's elevation to support the intake of Fort Worth's Holly Water Treatment Plant and the cooling operations at Lockheed Martin.

TRWD follows a series of operational rules to minimize spills and evaporation and regulate elevation in Lake Worth. The TRWD system operation plan calls for a shift in water deliveries to the Eastern Division reservoirs if the combined storage capacity in Lake Bridgeport and Eagle Mountain falls below 50 percent.

Construction of a new pipeline, carrying water from Cedar Creek and Richland-Chambers to Eagle Mountain Lake, was completed in May 2008. The 20.5-mile extension taps into an existing pipeline at Lake Benbrook and continues to Eagle Mountain Lake. Water from East Texas can now be delivered into Eagle Mountain Lake for terminal storage. The additional water will help meet the future water needs of a rapidly growing northwest Tarrant County and should reduce pressure on the West Fork during periods of peak demand (summer) and drought. It also supplies the expanded capacity of the city of Fort Worth's Eagle Mountain Water Treatment Plant.

Cedar Creek and Richland-Chambers reservoirs generate most of the water supply from the Eastern Division. Lakes Arlington and Benbrook are primarily operated as terminal storage reservoirs. Cedar Creek Reservoir is situated in Kaufman and Henderson counties; Richland-Chambers Reservoir is located in Navarro and Freestone counties; Lake Arlington is located on Village Creek in Tarrant County; and Lake Benbrook is a U.S. Army Corps of Engineers project in southwest Tarrant County.

The firm yield of Cedar Creek Reservoir is 175,000 acre-feet per year. A 70-mile pipeline is used to transport water from Cedar Creek into Tarrant County. An outlet on the Cedar Creek pipeline allows the Water District to deliver water into Village Creek which flows into Lake Arlington. Richland-Chambers has a firm yield of 210,000 acre-feet per year. The Water District constructed a 78-mile pipeline to carry water from Richland-Chambers into Tarrant County. Both East Texas pipelines terminate at the City of Fort Worth's Rolling Hills Water Treatment Plant. A pipeline extension from Rolling Hills to Lake Benbrook was completed in 1998.

TRWD manages deliveries from its East Texas reservoirs to meet customer needs and to supplement lake volumes in Eagle Mountain Lake, Lake Arlington, and Lake Benbrook during off-peak periods. The yields from the latter two lakes are less than 10,000 acre-feet per year so most of the supply is by pipeline delivery. Under normal operating conditions, the Water District diverts water in excess of demands into Lake Arlington and Lake Benbrook. The goal is to bring each of these lakes to at or near conservation elevation (694' msl and 550' msl, respectively) prior to June 1 to maximize terminal storage and meet peak demands during the summer. Using Lake Arlington and Lake Benbrook to provide summertime water deliveries to customers minimizes energy costs. Pumping from East Texas ceases if Lake Benbrook is above conservation. However, pumping will resume if demands exceed the pumping capabilities from Lake Benbrook.

The Water District has permits for two indirect reuse projects at Richland-Chambers and Cedar Creek Reservoirs. The projects involve diverting return flows in the Trinity River through constructed wetland systems to remove pollutants, such as nutrients and sediment. The water will then be routed to the reservoirs to supplement yields by as much as 30 percent. The wetland water reuse facility at Richland-Chambers began operations in spring 2009. Additional details about the water recycling projects can be found in Section 8.1.

6.3 Water Conservation Implementation Report

Appendix D includes the TCEQ required water conservation implementation report. The report is due to the TCEQ by May 1, 2014, and every five years after that date. This report tracks water demands over a five-year period and provides an overview of TRWD's water conservation programs. The report also calls for the five and ten year per capita water use goals from the previous water conservation plan. The reporting entity must answer whether or not these goals have been met and if not, why not. The amount of water savings is also reported.

6.4 Coordination with Regional Water Planning Groups

Appendix L includes a copy of letters sent to the Chairs of Region C and Region D water planning groups with this water conservation and drought contingency plan.

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7. ADDITIONAL TRWD WATER CONSERVATION MEASURES TO ASSIST CUSTOMERS

TRWD will implement a number of water conservation measures intended to help direct and indirect customers with their water conservation planning, including:

- Holding water conservation workshops for the staff of customers within its service area.
- Providing model water conservation and drought contingency plans for use by customers in developing their own plans.
- Requiring an annual report on water conservation efforts from customers and developing a district water conservation report.

These measures will allow TRWD to serve as a regional resource for water conservation efforts in its service area.

7.1 Water Conservation Workshops

The Water District will continue to coordinate water conservation workshops for staff of customers (direct and indirect) that receive water from TRWD. The workshops will cover TCEQ requirements for water conservation and drought contingency plans, current TRWD water conservation efforts, water supply updates, municipal water conservation programs and best management practices, and related topics. TRWD has made available the model water conservation and drought contingency plans described in Section 7.2 to cities and assist in the development of their plans.

In 2007, the Water District held the first water conservation symposium for its customer cities, which is now an annual event. The program is designed to show customers strategies they can use to save water, save money, and reduce demands. Speakers from across the nation are invited to share their experience and expertise. Discussions center on key elements of successful water conservation programs. The symposium's success attracted the attention of other water suppliers. And in 2008, the event was expanded and is now jointly coordinated by the region's three major water providers – TRWD, North Texas Municipal Water District, and Dallas Water Utilities.

In addition to the symposium, the Water District joined other North Texas water suppliers, and the Dallas and Fort Worth Chambers of Commerce to coordinate a Legislative Summit in October 2008 for state and local lawmakers. The event, which focused on water supply and conservation issues impacting North Texas, was repeated for water utility managers and their staff.

Additional water conservation workshops and educational programs targeting end water users continue to play a role in the Water District's community outreach program. Further information on TRWD's public education and water conservation programs is listed in Section 8.2.

7.2 TRWD *Model Water Conservation Plan for TRWD Customers* and *Model Drought Contingency Plan for TRWD Customers*

In order to assist its cities in the development of their own water conservation and drought contingency plans, TRWD will develop a *Model Water Conservation Plan for TRWD Customers* and a *Model Drought Contingency Plan for TRWD Customers*. The model water conservation plan addresses the TCEQ requirements for water conservation plans for municipal use by public water suppliers and includes several provisions that go beyond TCEQ requirements. TRWD will work with its customers to develop water conservation and drought contingency plans using the model plan as a guide.

The model water conservation plan includes the following elements addressing TCEQ requirements for water conservation plans for public water suppliers: [1]

- 288.2(a)(1)(A) – Utility Profile
- 288.2(a)(1)(B) – Record Management, Customer Classification
- 288.2(a)(1)(C) – Specification of Goals
- 288.2(a)(1)(D) – Accurate Metering
- 288.2(a)(1)(E) – Universal Metering
- 288.2(a)(1)(F) – Determination and Control of Unaccounted Water
- 288.2(a)(1)(G) – Public Education and Information Program
- 288.2(a)(1)(H) – Non-promotional Water Rate Structure
- 288.2(a)(1)(I) – Reservoir System Operation Plan
- 288.2(a)(1)(J) – Means of Implementation and Enforcement
- 288.2(a)(1)(K) – Coordination with Regional Water Planning Group
- 288.2(a)(2)(A) – Leak Detection, Repair, and Water Loss Accounting
- 288.2(a)(2)(B) – Record Management System
- 288.2(a)(2)(C) – Requirement for Water Conservation Plans by Wholesale Customers

TRWD's model water conservation plan also includes water conservation strategies that go beyond TCEQ's requirements:

- 288.2(a)(3)(A) – Conservation Oriented Water Rates
- 288.2(a)(3)(B) – Ordinances, Plumbing Codes or Rules on Water-Conserving Fixtures
- 288.2(a)(3)(D) – Reuse and Recycling of Wastewater
- 288.2(a)(3)(F) – Landscape Water Management Ordinance
- 288.2(a)(3)(G) – Monitoring Method

7.3 Annual Reports

One element of TRWD's *Model Water Conservation Plan for TRWD Customers* is a requirement that all water supply customers (direct and indirect) produce annual conservation reports (Appendix F) by May1 the following year and submit them to TRWD. TRWD will compile these reports and use them to help generate its own annual water conservation report. The Water District's report will be used to review the effectiveness of its water conservation program.

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8. ADDITIONAL TRWD WATER CONSERVATION MEASURES

8.1 Indirect Reuse and Recycling of Water

Indirect and/or direct reuse is a major part of future water supply plans for North Texas. TRWD is taking a lead role in water reuse by recycling return flows in the Trinity River. Return flows are a renewable resource; they are made up of water discharged by wastewater treatment plants in Fort Worth-Dallas area. A large portion of those flows originated from reservoirs managed by the Water District.

Here's how indirect reuse projects work:

A) Treated water from area lakes is consumed in homes and business.

B) Water that flows down the drain ends up at a wastewater treatment plant.

C) Wastewater treatment plants clean the water and release it into the Trinity River. However, discharges from wastewater treatment plants can contain elevated levels of nutrients, such as nitrogen and phosphorus.

D) As the water flows downstream, it picks up sediments, more nutrients, and other pollutants along the way.

E) The return flows are captured and pumped into constructed wetlands. The wetlands provide a natural way to remove sediments and nutrients from the river water.

F) With most of the sediments and nutrients removed, the naturally treated water is returned to area lakes to supplement drinking water supplies.

G) Water from lakes is pumped to drinking water treatment plants, then back into homes and businesses and reused.

The first of TRWD's two planned indirect reuse projects began supplementing water supplies in fall 2013. The George Shannon Wetlands Water Recycling Facility is a 2,000-acre constructed wetland system adjacent to Richland-Chambers Reservoir. The project is permitted to supply 63,000 acre-feet of treated river water to the reservoir annually, which averages out to more than 56 million gallons per day (MGD). Over the next five years, the Water District plans to recycle enough water from the Trinity River to make up more than 10 percent of its raw water supplies.

Another 2,000-acre facility is planned for Cedar Creek Reservoir, as water demands increase. When completed, the second wetland project will add 52,500 acre-feet to the reservoir. These unique projects will ultimately supplement current yields in each reservoir by 30 percent.

8.2 Public Education Program

TRWD will work closely with its customers (direct and indirect) to inform consumers on ways to use water more efficiently. TRWD's public education program is intended to

assist and supplement the public education efforts of its customers. TRWD's public education efforts include the following elements:

New conservation initiatives implemented by TRWD since 2009:

Public Education and Media Outreach Campaign

- TRWD continues to support the regional water conservation outreach campaign with Dallas Water Utilities. And media outreach is a huge factor in educating residents about water efficiency and ways to reduce water waste. The program has been successful. A recent survey of Tarrant County residents indicates that 62 percent of respondents have changed their behavior to be more efficient as a result of our outreach campaign, and 84 percent water twice per week or less, which has been the main message of our campaign in recent years.

Strategic Water Conservation Plan Implementation

- After a multi-year effort, Alan Plummer and Associates, Inc. finalized a Strategic Water Conservation Plan for the Water District in 2013. The executive summary from the plan is included in Appendix G.

  The plan evaluates customer water use, current water conservation programs, and proposes a lineup of new water saving strategies to build on our success. Understanding the driving forces behind our water use patterns, predicting how those conditions will impact water supplies, and developing a strategic roadmap to guide the implementation of future conservation policies will keep us focused on effective ways to support customer water conservation efforts.

  The Strategic Plan evaluated the cost and effectiveness of twenty water conservation measures. These particular strategies were screened and selected because of their water savings potential, customer feedback, and their applicability to the majority of customers in the water district's service area. The top six measures projected to generate the highest per capita savings included a combination of active and passive measures[i]:

  - Twice per week irrigation limits 6.20 gpcd
  - Water use reductions due to price increases 4.74 gpcd
  - Natural toilet replacement 1.07 gpcd
  - Clothes washer natural replacement 0.96 gpcd
  - Model water conservation ordinance 0.62 gpcd
  - Wholesale customer water loss reduction 0.42 gpcd

  By 2017, the Plan estimates the total per capita savings generated by these measures will be 14.01 gallons per day. These six measures represent 89.8 percent of all the water savings outlined in the Plan.

Putting the Strategic Water Conservation Plan into motion is high on our priority list. Representatives of our primary customers are helping to guide the lineup of strategies to pursue. Items on the list that are in progress include the development of a best management program for golf courses, a draft model landscape ordinance, and a water loss reduction program, consisting of workshops and the development and tracking of performance indicators. The Water District is also supporting a popular homeowner irrigation evaluation program (described below) on a small scale for its customers.

Twice-per-Week Watering Restrictions

- Outdoor water use, particularly lawn watering, can account for half or more of annual residential water use – and much more than that during the hot, dry Texas summers. And studies show that homeowners have a tendency to overwater, by as much as 2-3 times the amount needed by landscapes. Placing limits on outdoor irrigation is one way to reducing excessive water use outdoors and stretch existing supplies. A white paper containing additional details about the effectiveness of using twice-per-week outdoor irrigation schedules to conserve water is included in Appendix H.

  As the number one conservation strategy in its Strategic Plan, the Water District fully supports the efforts of its customer cities to adopt year-round twice-per-week watering restrictions. In fact, we recently worked with staff from Fort Worth Water Department to assist them in their effort to pass a mandatory twice per week watering ordinance (April 2014). A copy of the Fort Worth irrigation ordinance is included in Appendix I.

Irrigation Auditing Program

- The W.I.S.E. Guys program is a residential irrigation evaluation program that uses trained licensed irrigators to assess homeowner irrigation systems. Upon inspection they make recommendations for improving system performance, identify repair needs, and instruct users on how to schedule controllers to eliminate unnecessary outdoor watering.

  The evaluation includes an opportunity for a professional irrigator to educate homeowners about their systems, how to program them properly, and offer guidance on how much and how long to water throughout the year. Up to 500 irrigation evaluations will be provided through the program.

  In addition to the watering guidance, the pricing of this program includes the installation of a rain and freeze sensor for participants who do not have one already installed. Communities participating in the program this year include Arlington, Bedford, Hurst, Keller, Mansfield, North Richland Hills, and Fort Worth.

Airfield Falls Trailhead Water Conservation Garden

- In conjunction with the creation of a trail extension and a new trailhead on a tributary of the West Fork of the Trinity River, TRWD is building a destination

water conservation garden. The garden will be used to educate homeowners, developers, and landscapers about the benefits of water efficient landscaping. Phase 1 of the garden will be complete this spring. Phase 2 extending the garden further along the trail will begin in the fall.

The garden will feature an array of themes that homeowners can incorporate into their landscape. Topics of education will include planning and design, soil analysis and preparation, plant selection, practical turf and turf areas, efficient irrigation, mulching, and landscape best management practices.

ET Weather Station Support and Climate-based Weekly Watering Recommendations

- TRWD is installing two additional weather stations in Tarrant County to complement the one already operating at the National Weather Service. The TRWD stations will be integrated into the Texas ET Network and enable us to provide accurate weekly watering advice for Tarrant County residents on SaveTarrantWater.com. Development of the web site is in progress.

  The idea is to give residents the information they need to water appropriately and to reduce overwatering. We are currently sharing this information on the Lawn Whisperer and Save Tarrant Water Facebook pages. Last year, we received enough rainfall in Tarrant County to skip watering the lawn for a total of 33 weeks. It's important information that we also hope to share with media outlets, including radio, television, and newspapers.

Drought Outreach and Customer Assistance

- With drought potentially looming on the horizon in any given year, the water district offers regional support to customer cities. The support mainly consists of developing media messages for use on television, radio, web, and in print outlets. The media effort focuses on educating water users on drought stage restrictions and mandatory outdoor watering schedules. In the past, TRWD has covered the cost of printing sign materials for customer use throughout its service area.

Main Street Arts Festival Environmental Sponsorship

- The sponsorship gives the water district an opportunity to promote the "Save Water. Nothing can replace it." campaign at the largest four day event in the Southwest. And as an official sponsor, we can incorporate the save water message into the Main Street PR, marketing and advertising campaign leading up to the festival and throughout the event site.

  Some of the funding is used to support branded watering stations to dispense free, U/V filtered and refrigerated water to patrons with their own containers. A space for our mobile water conservation trailer is also provided.

Alliance for Water Efficiency Membership Tracking Tool

- Purchase Alliance for Water Efficiency annual membership for customer cities. One primary benefit of membership is "free" access to the AWE Water Conservation Tracking Tool.

The Tool is an Excel-based model that can evaluate the water savings, costs, and benefits of conservation programs for a specific water utility, using either English or Metric units. Using information entered into the Tool from the utility's system, it provides a standardized methodology for water savings and benefit-cost accounting, and includes a library of pre-defined conservation activities from which users can build conservation programs.

WaterWise 5th Grade Education Curriculum

- Educating future water users about water conservation is a key responsibility of water providers. The District partners with several communities on a shared-cost basis to provide 5th grade classes with the Water Wise educational toolkit. The program kits and activities put water knowledge and conservation center stage at school and at home. The kits provide "students and their families with the tools needed to audit and retrofit their homes with water saving devices. District partners include Arlington, Bedford, Fort Worth and North Richland Hills.

Additional Programs

- Water Conservation Workshops and program materials, Major Rivers Educational Curriculum for Forth Worth ISD middle school students, Water Conservation Regional Symposium, customer supported Home and Garden Shows.

Additional information on programs implemented by TRWD prior to 2009 can be found in the TCEQ Water Conservation Implementation Report in Appendix D. Refer to the report dated April 9, 2009.

8.3 In-House Water Conservation Efforts

TRWD has and will continue to implement and in-house water conservation program, including the following elements:

- Wherever possible, landscapes will use native or adapted drought tolerant plants, trees and shrubs.
- Irrigation at TRWD facilities will occur before 10 a.m. and after 6 p.m. year-round in order to lower losses due to evaporation.
- Irrigation will be limited to the amount needed to promote survival and health of plants and lawns. The Water District has eliminated irrigation at some pump station locations altogether.
- Irrigation will be avoided on Saturday and Sunday if possible, since these are periods of high water use by the public.
- Irrigation will be done with untreated source water wherever feasible and reasonable.

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9. ADOPTION AND AUTHORIZATION TO ENFORCE THE WATER CONSERVATION AND DROUGHT CONTINGENCY PLAN

Appendix K contains a copy of the minutes of the TRWD Board meeting at which this amended water conservation and drought contingency plan was adopted. The General Manager of TRWD is authorized to implement and enforce, to the extent provided herein, the water conservation and drought contingency plan. As discussed in Section 7.3 TRWD will prepare a water conservation report every year, incorporating the reports required from direct and indirect customers. This report will be used to review the effectiveness of TRWD's water conservation program, and results will be reported to the Advisory Committee and the TRWD board.

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10. REVIEW AND UPDATE OF WATER CONSERVATION PLAN

TCEQ requires that water conservation plans be updated prior to May 1, 2009 and every five years thereafter. TRWD will review and update this plan as appropriate based on new or updated information.

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11. DROUGHT CONTINGENCY PLAN

11.1 Introduction

The purpose of this drought contingency plan is as follows:

- To conserve the available water supply in times of drought and emergency
- To maintain supplies for domestic water use, sanitation, and fire protection
- To protect and preserve public health, welfare, and safety
- To minimize the adverse impacts of water supply shortages
- To minimize the adverse impacts of emergency water supply conditions.

As this plan is being prepared (February 2014), TRWD is in a Stage 1 drought. The lack of rainfall and runoff along with record breaking temperatures in previous years has dramatically affected lake levels. In response to the drought conditions, TRWD is updating its water conservation and drought contingency plans to take a more active role in educating the public about the importance of using water more efficiently, changing behaviors to reduce water waste, and working with the community to have a positive impact.

TRWD recognizes the need for developing a regional approach to implementing water conservation strategies. The Water District has worked closely with other water suppliers to create an educational outreach campaign with unified themes and messages. The campaign is designed to provide people with information and tools that can be used to save water. The extensive effort consists of multiple methods to reach and educate the public, including:

- Television ads
- Radio ads
- Transit ads
- Billboards
- Yard signs
- Newspaper and magazine ads
- Movie theater ads
- Fact sheets
- Web sites
- Social Media
- An ongoing print and media relations campaign with print and electronic media

- Other outreach programs, such as a traveling exhibit for community events and meetings with representatives of plumbing, landscape irrigation, nurseries, and other industries with influence on water use.

The specifics of the public outreach and education campaign will vary depending on the circumstances of future droughts, but this current example shows TRWD's commitment to an appropriate drought response.

11.2 State Requirements for Drought Contingency Plans

This drought contingency plan is consistent with the Texas Commission on Environmental Quality (TCEQ) guidelines and requirements for the development of drought contingency plans by wholesale water suppliers, contained in Title 30, Part 1, Chapter 288, Subchapter B, Rule 288.22 of the Texas Administrative Code. This rule is included in Appendix B.

Minimum Requirements

TCEQ's minimum requirements for drought contingency plans are addressed in the following subsections of this report:

- 288.22(a)(1) – Provisions to Inform the Public and Provide Opportunity for Public Input – Section 11.3
- 288.22(a)(2) – Coordination with the Regional Water Planning Group – Section 11.9
- 288.22(a)(3) – Criteria for Initiation and Termination of Drought Stages – Section 11.4
- 288.22(a)(4) – Drought and Emergency Response Stages – Section 11.5
- 288.22(a)(5) – Procedures for Initiation and Termination of Drought Stages – Section 11.5
- 288.22(a)(6) – Specific, Quantified Targets for Water Use Reductions – Section 11.5
- 288.22(a)(7) – Specific Measures to Be Implemented during Each Drought Stage – Section 11.5
- 288.22(a)(8) – Provision for Wholesale Contracts to Require Water Distribution According to Texas Water Code §11.039 – Sections 11.5 and 11.6.
- 288.22(a)(9) – Procedures for Granting Variances to the Plan – Section 11.7
- 288.22(a)(10) – Procedures for Enforcement of Mandatory Restrictions – Section 11.8
- 288.22(b) – Notification of Implementation of Mandatory Measures – Section 11.4
- 288.22(c) – Review and Update of Plan – Section 11.10

11.3 Provisions to Inform the Public and Opportunity for Public Input

TRWD provided opportunity for public input in the development of this drought contingency plan by the following means:

- Several meetings with customer representatives were held to discuss and coordinate the development of this plan.
- The District will provide the draft plan to anyone requesting a copy.
- The proposed plan was posted to SaveTarrantWater.com web site (May 5, 2014) providing the public an opportunity to review and comment on the plan in writing.
- Public comment was available at the Tarrant Regional Water District board meeting held at the District offices in Fort Worth, at the time of adoption.

This version of the drought contingency plan does include updates. Most of the 2009 drought contingency plan remains intact; however some measures and actions in this plan were modified in order to specifically match those contained in the plans of other North Texas water providers. The changes made to this plan are consistent with taking a regional approach to conserve water in times of drought or emergency. The regional effort to achieve consistency among water provider drought plans was a direct result of discussions among the region's largest water suppliers, including TRWD, Dallas Water Utilities (DWU), North Texas Municipal Water District (NTMWD), and Upper Trinity Regional Water District (UTRWD). The public was invited to submit its input at the Water District board meeting held at 9:30 a.m., on Tuesday, May 20, 2014. For those who wished to submit comments, but were unable to attend the meeting, TRWD posted this plan on its SaveTarrantWater.com Web site.

11.4 Initiation and Termination of Drought Response Stages

Initiation of Drought Response Stage

The General Manager may order the implementation of a drought response stage or water emergency when one or more water supply trigger conditions is met. The following actions will be taken when a drought stage is initiated:

- The designated representative(s) of primary wholesale customers will be notified by email, mail, telephone, or fax that provides details of the reasons for initiation of the drought stage.
- The public will be notified through local media following the notification of primary wholesale customers.
- If any mandatory provisions of the drought contingency plan are activated, TRWD will notify TCEQ within five business days.

Notwithstanding the foregoing, the General Manager may decide, under special circumstances, not to order the implementation of a drought response stage or water emergency even though one or more of the trigger criteria for the stage are met. Factors which could influence such a decision include, but are not limited to, the time of year,

weather conditions, the anticipation of replenished water supplies, or the anticipation that additional facilities will become available to meet needs.

The trigger conditions in this plan pertaining to TRWD's system volume were established following an intensive study of the North Texas climate and its impact on water supplies by Hydrosphere, an engineering firm based in Boulder, Colorado. The 2007 study projected the effects of simulated weather patterns on the combined storage capacity of TRWD reservoirs. Using computer simulations, Hydrosphere compared the water savings that would be achieved at various trigger points with and without outdoor watering restrictions in place. Under severe drought conditions, the estimated water savings that would be achieved by implementing this plan would extend water supplies by several weeks. A more detailed summary of the study's findings is included in Appendix M.

Termination of a Drought Stage

The General Manager will order the termination of a drought response stage or water emergency when the conditions for termination are met. The following actions will be taken when a drought stage is terminated:

- The designated representative(s) of primary wholesale customers will be notified by email, mail, telephone, or fax that provides details of the reasons for termination of the drought stage.
- The public will be notified through local media following the notification of primary wholesale customers.
- When mandatory provisions of the drought contingency plan that have been activated are terminated, TRWD will notify the Executive Director of the TCEQ within five business days.

Notwithstanding the foregoing, the General Manager may decide, under special circumstances, not to order the termination of a drought response stage or water emergency even though conditions for termination of the stage are met. Factors which could influence such a decision include, but are not limited to, the time of year, weather conditions, or the anticipation of potential changes in conditions that warrant the continuation of the drought stage.

11.5 Drought and Emergency Response Stages and Measures

Stage 1, Water Watch

Triggering and Terminating Conditions

- Total combined raw water supply in TRWD western and eastern division reservoirs drops below 75% (25% depleted) of conservation storage capacity.
- Water demand for all or part of the delivery system approaches delivery capacity because delivery capacity is inadequate.
- One or more of TRWD's water supply sources has become limited in availability.

- Water demand is projected to approach the limit of permitted supply.
- Supply source becomes contaminated.
- Water supply system is unable to deliver water due to the failure or damage of major water system components.
- The General Manager finds that conditions warrant the declaration of a Stage 1 drought.

Subject to preceding paragraphs regarding the Termination of a Drought Response stage, Stage 1, Water Watch, will be terminated when the total combined raw water supply in TRWD's western and eastern division reservoirs exceeds 95% of conservation storage or remains above 85% for 90 consecutive days, whichever occurs first.

Goal for Use Reduction

The goal for water use reduction under Stage 1, Water Watch, is to decrease use by five percent. If circumstances warrant, the General Manager can set a goal for greater water use reduction.

Water Use Reduction Actions under Stage 1, Water Watch

The General Manager may order the implementation of any of the actions listed below, as deemed necessary. Measures imposing mandatory requirements on customers require notification to TCEQ. TRWD must notify TCEQ within five business days if any mandatory measures are implemented.

- Require customers (including indirect customers) to initiate Stage 1 in their drought contingency plans. Indirect customers include any successive wholesale customers of TRWD's primary wholesale customers to the extent provided for in water sales contracts.

All Water Users

- Maximum of twice per week watering for hose-end sprinklers and automatic irrigation systems based on odd/even addresses and day of week schedule.

Stage 1, Water Watch, Outdoor Watering Schedules		
Monday	No Outdoor Watering	Water System Recovery Day
Tuesday and Friday	Non-Residential Sites	Apartments, Parks, Common Areas, HOA's, Businesses
Wednesday and Saturday	Residential Addresses Ending in Even Numbers	0,2,4,6,8
Thursday and Sunday	Residential Addresses Ending in Odd Numbers	1,3,5,7,9

Exceptions:

- Watering with a handheld hose, soaker hose or drip irrigation may occur any day and any time.
- Watering of trees and structural foundations may occur any day and any time by means of handheld hose, soaker hose, or drip irrigation.
- The use of water necessary to protect the health, safety, or welfare of the public.
- Water use necessary for the repair of an irrigation system, plumbing line, fountain, etc. in the presence of person making repair.
- Variances may be available through the District for the following:
    - Establishing new turfgrass and/or landscaping. Variances granted for establishing new turfgrass or landscaping will be for a maximum of 30 days from the date of approval then maximum of twice per week watering schedule applies.
    - Variances do not apply to the installation (over seeding) of cool season grasses.
    - Outdoor watering at addresses with large multi-station irrigation systems may take place in accordance with a variance granted by the District, if the District determines that a property cannot be completely irrigated under the twice per week schedule. Under such variance, no irrigation station will be allowed to water more than twice per week.
    - Areas open to the public and have high-impact from frequent use may be allowed additional watering with a variance granted by the District if it is deemed to be beneficial to serve and protect the community facility or amenity.
    - Restrictions do not apply to locations using well water, reclaimed water, or other alternative water sources.

- No watering with hose-end sprinklers and/or automatic spray irrigation systems between the hours of 10 a.m. and 6 p.m.
- Prohibit using water in such a manner as to allow runoff or other waste, including:
    - failure to repair a controllable leak, including, broken sprinkler heads, leaking valves, leaking or broken pipes or faucets;
    - operating an irrigation system with: (a) a broken head; (b) a head that is out of adjustment and spraying into the street, parking area, or sidewalk; or (c) a system that is misting/fogging due to excessive water pressure; or

  - allowing any water to: (a) run off property forming a stream of water for a distance of 50 feet or greater; (b) run into a storm drain; or (c) pond to a depth of ¼ inch or greater; or
  - allowing or causing an irrigation system or other lawn watering device to operate during any form of precipitation or when temperatures are at or below 32 degrees Fahrenheit.

- All users are encouraged to use native and adapted drought tolerant plants in landscaping.
- Discourage hosing of paved areas.
- Discourage hosing of buildings or other structures for purposes other than fire protection or surface preparation prior to painting or maintenance.
- Washing of any motor vehicle, motorbike, boat, trailer, airplane, or other vehicle shall be limited to the use of a hand-held bucket or a hand-held hose equipped with a positive-pressure shutoff nozzle for quick rinses. Vehicle washing may be done at any time on the premises of a commercial car wash or commercial service station. Companies with automated on-site vehicle washing facilities may wash its vehicles at any time.
- Discourage the filling, draining, or refilling of swimming pools, wading pools, hot tubs and Jacuzzi type pools except to maintain adequate water levels for structural integrity, proper operation and maintenance, and/or to alleviate an issue that poses a public safety risk.

<u>City and Local Governments</u>

- Review conditions and problems that caused Stage 1. Take corrective action.
- Increase public education efforts on ways to reduce water use.
- Increase enforcement efforts.
- Intensify leak detection and repair efforts.
- Audit all city and local government irrigation systems to ensure proper condition, settings, and operation.
- Identify and encourage voluntary reduction measures by high-volume water users through water use audits.
- Landscape watering of municipal parks, golf courses and athletic fields is restricted to a twice per week watering schedule; or twice per week per irrigation station if a variance is granted by the Water District. (See exceptions to outdoor watering restrictions in all water users category above for facilities with large multi-station irrigation systems.)

Exceptions:

- Golf courses may water greens and tee boxes as necessary, however, use of spray irrigation may not be done between 10 a.m. and 6 p.m. Encouraged to reduce water use by five percent.
- Watering of athletic fields (field only, does not include surrounding landscaped areas) used for organized sports practice, competition, or exhibition events may occur as necessary to protect the health and safety of the players, staff, or officials present for athletic events. Encouraged to reduce water use by five percent.

- Reduce non-essential water use. As used herein, non-essential water uses are those that do not have a health or safety impact and are not needed to meet the core function of the agency.
- Notify wholesale customers of actions being taken and request them to implement the same drought stage and measures.

Commercial or Industrial

- All actions listed above for all water users apply to commercial and industrial users.
- Landscape watering of parks, golf courses and athletic fields is restricted to the twice per week watering schedule; or twice per week per irrigation station if a variance is granted by the water provider. (See exceptions to outdoor watering restrictions in all water users category above for facilities with large multi-station irrigation systems.)

  Exceptions:

  - Golf courses may water greens and tee boxes as necessary, however, use of spray irrigation may not be done between 10 a.m. and 6 p.m. Encouraged to reduce water use by five percent.
  - Watering of athletic fields (field only, does not include surrounding landscaped areas) used for organized sports practice, competition, or exhibition events may occur as necessary to protect the health and safety of the players, staff, or officials present for athletic events. Encouraged to reduce water use by 5 five percent.
- Stock at commercial plant nurseries is exempt from Stage 1 watering restrictions.
- Hotels, restaurants, and bars are encouraged to serve drinking water to patrons per request only.
- Hotels are encouraged to implement laundry conservation measures by encouraging patrons to reuse linens and towels.
- Car wash facilities must keep equipment in good working order, which should include regular inspections to be sure there are no leaks, broken or misdirected nozzles, and that all equipment is operating efficiently.

- All commercial and industrial customers are encouraged to audit irrigation systems to ensure proper condition, settings, and operation. If irrigation audit or repair occurs during restricted watering times or days, a sign indicating such work is taking place must be placed in public view until job is completed.

Stage 2, Water Warning

Triggering and Terminating Conditions

- Total raw water supply in TRWD western and eastern division reservoirs drops below 60% (40% depleted) of conservation storage capacity.
- Water demand for all or part of the delivery system approaches delivery capacity because delivery capacity is inadequate.
- One or more of TRWD's water supply sources has become limited in availability.
- Water demand is projected to approach the limit of permitted supply.
- Supply source becomes contaminated.
- Water supply system is unable to deliver water due to the failure or damage of major water system components.
- The General Manager finds that conditions warrant the declaration of a Stage 2 drought.

Subject to preceding paragraphs regarding the Termination of a Drought Response stage, Stage 2, Water Warning, will be terminated when the Total combined raw water supply in TRWD's western and eastern division reservoirs exceeds 75% of conservation storage or remains at or above 70% for 30 consecutive days, whichever occurs first.

Goal for Use Reduction

The goal for water use reduction under Stage 2, Water Warning, is to decrease use by 10 percent. If circumstances warrant, the General Manager can set a goal for greater water use reduction.

Water Use Reduction Actions under Stage 2, Water Warning

The General Manager may order the implementation of any of the actions listed below, as deemed necessary. Measures imposing mandatory requirements on customers require notification to TCEQ. TRWD must notify TCEQ within five business days if any mandatory measures are implemented.

- Continue actions under Stage 1.
- Require customers (including indirect customers) to initiate Stage 2 in their drought contingency plans. Indirect customers include any wholesale customer of TRWD's primary wholesale customers to the extent provided for in water sales contracts.

- Initiate engineering studies to evaluate water supply alternatives should conditions worsen.

All Water Users

- Maximum of once per week watering for hose-end sprinklers and automatic irrigation systems at each service address.
- An effort will be made by TRWD and its primary customers to coordinate once per week watering schedules to simplify messages passed to customers through the news media. However, due to the variation in water storage and delivery systems of TRWD customers, specific watering days per address may vary across TRWD's service area.

  Exceptions:

  - Watering with a handheld hose, soaker hose or drip irrigation may occur any day and any time.
  - Watering of trees and structural foundations may occur any day and any time by means of handheld hose, soaker hose, or drip irrigation.
  - Variances may be available through the District for the following:
    - All users are encouraged to wait until the current drought or emergency situation has passed before establishing new landscaping. Variances granted for establishing new turfgrass or landscaping will be for a maximum of 30 days from the date of approval then maximum of once-per-week watering schedule applies.
    - Variances do not apply to the installation (over seeding) of cool season grasses.
    - Outdoor watering at addresses with large multi-station irrigation systems may take place in accordance with a variance granted by the District, if the District determines that a property cannot be completely irrigated under the once per week schedule. Under such variance, no irrigation station will be allowed to water more than once per week.
    - Areas open to the public and have high-impact from frequent use may be allowed additional watering with a variance granted by the District if it is deemed to be beneficial to serve and protect the community facility or amenity.
    - Restrictions do not apply to well water, reclaimed water, or other alternative water sources.
- Encourage the use of covers for all types of pools, hot tubs, and Jacuzzi type pools when not in use.

City and Local Governments

In addition to the actions listed above:

- Continue actions under Stage 1.
- Review conditions or problems that caused Stage 2. Take corrective action.
- Increase frequency of media releases on water supply conditions.
- Further accelerate public education efforts on ways to reduce water use.
- Landscape watering of municipal parks, golf courses and athletic fields is restricted to a once-per-week schedule; or once-per-week per irrigation station if a variance is granted by the water provider. (See Stage 1 exceptions to outdoor watering restrictions in all water users category for facilities with large multi-station irrigation systems.)

  Exceptions:

  - Golf courses may water greens and tee boxes as necessary, however, use of spray irrigation may not be done between 10 a.m. and 6 p.m. Encouraged to reduce water use by ten percent.
  - Watering of athletic fields (field only, does not include surrounding landscaped areas) used for organized sports practice, competition, or exhibition events may occur as necessary to protect the health and safety of the players, staff, or officials present for athletic events. Encouraged to reduce water use by ten percent.

- Eliminate non-essential water use. As used herein, non-essential water uses are those that do not have any health or safety impact and are not needed to meet the core function of the agency.
- Notify wholesale customers of actions being taken and request them to implement the same drought stage and measures.

Commercial or Industrial

- All actions listed above for all water users apply to commercial and industrial users.
- Landscape watering of municipal parks, golf courses and athletic fields is restricted to a once-per-week schedule; or once-per-week per irrigation station if a variance is granted by the water provider. (See Stage 1 exceptions to outdoor watering restrictions in all water users category for rules that apply to facilities with large multi-station irrigation systems.)

  Exceptions:

  - Golf courses may water greens and tee boxes as necessary, however, use of spray irrigation may not be done between 10 a.m. and 6 p.m. Encouraged to reduce water use by ten percent.

- Watering of athletic fields (field only, does not include surrounding landscaped areas) used for organized sports practice, competition, or exhibition events may occur as necessary to protect the health and safety of the players, staff, or officials present for athletic events. Encouraged to reduce water use by ten percent.

Stage 3, Water Emergency

Triggering and Terminating Conditions

- Total raw water supply in TRWD western and eastern division reservoirs drops below 45% (55% depleted) of conservation storage capacity.
- Water demand exceeds the amount that can be delivered to customers.
- Water demand for all or part of the TRWD delivery system approaches delivery capacity because delivery capacity is inadequate.
- One or more of TRWD's water supply sources has become limited in availability.
- Water demand is projected to approach the limit of permitted supply.
- Supply source becomes contaminated.
- Water supply system is unable to deliver water due to the failure or damage of major water system components.
- The General Manager finds that conditions warrant the declaration of a Stage 3 drought.

Subject to preceding paragraphs regarding the Termination of a Drought Response stage, Stage 3, Water Emergency, will be terminated when the total combined raw water supply in TRWD's western and eastern division reservoirs exceeds 60% of conservation storage or remains at or above 55% for 30 consecutive days, whichever occurs first.

Goal for Use Reduction

The goal for water use reduction under Stage 3, Water Emergency, is to decrease use by 20 percent. If circumstances warrant, the General Manager can set a goal for greater water use reduction.

Actions Available under Stage 3, Water Emergency

The General Manager can order the implementation of any of the actions listed below, as deemed necessary. Measures imposing mandatory requirements on customers require notification to TCEQ. TRWD must notify TCEQ within five business days if these measures are implemented.

- Continue actions under Stages 1 and 2.
- Require customers (including indirect customers) to initiate Stage 3 in their drought contingency plans. Indirect customers include any wholesale customer of

TRWD's primary wholesale customers to the extent provided for in water sales contracts. .

All Water Users

- Prohibit all outdoor watering with hose-end sprinklers and automatic irrigation systems, including at parks, golf courses, and sports fields.

  Exceptions:

  - Watering with hand-held hose, soaker hose or drip irrigation system may occur any day and any time.
  - Watering of trees and structural foundations may occur any day and any time by means of handheld hose, soaker hose, or drip irrigation.
  - Restrictions do not apply to well water, reclaimed water, or other alternative water sources.
  - Irrigation of new landscapes and/or turfgrass installations is prohibited by means of automatic irrigation system or hose-end sprinkler. Variances may be granted for those landscape projects started prior to the initiation of stage 3 drought restrictions. However, variances will not be granted for the irrigation of new landscape and/or turfgrass installations after the initiation of Stage 3 drought restrictions.
  - Prohibit washing of paved areas by any means except where a variance is granted to alleviate a possible public health and safety risk. Any pressure/power washing activities must be performed by a professional pressure/power washing service provider utilizing high efficiency equipment and a vacuum recovery system where possible.
  - Prohibit hosing of buildings or other structures for purposes other than fire protection or surface preparation prior to painting with high-pressure equipment. Services must be performed by a professional pressure/power washing service provider utilizing high efficiency equipment and a vacuum recovery system where possible.
  - Vehicle washing is restricted to commercial car washes, commercial service stations, or professional washing services only. This includes home and charity car washing. The washing of garbage trucks and vehicles used to transport food and/or other perishables may take place as necessary for health, sanitation, or public safety reasons.
  - Prohibit permitting of private pools. Pools already permitted may be completed and filled. Existing private and public pools may add water to maintain pool levels, but may not be drained and refilled.
  - Prohibit the operation of ornamental fountains or ponds that use potable water except where necessary to support aquatic life or water quality.
  -

City and Local Governments

- Continue actions under Stages 1 and 2.
- Review conditions or problems that caused Stage 3. Take corrective action.
- Increase frequency of media releases explaining emergency situation and/or water supply conditions. .
- Landscape watering at municipal parks, golf courses, and sports fields is prohibited. Variances may be granted by the water provider under special circumstances.

  Exceptions:

  - Golf course greens and tee boxes may be watered by hand as necessary.
  - Variances may be available for watering of athletic fields (field only, does not include surrounding landscaped areas) used for organized sports practice, competition, or exhibition events to protect the health and safety of the players, staff, or officials present for the athletic event.
  - Professional and college sports fields (playing fields with a stadium only – not surrounding landscaping) may be watered as necessary to maintain league standards.
- Institute a mandated reduction in deliveries to all wholesale customers. Such a reduction will be distributed as required by Texas Water Code §11.039.
- If TRWD has imposed a reduction in water available to customers, impose the same percent reduction on wholesale customers.

Commercial or Industrial

- All actions listed above for all water users apply to commercial and industrial users. Landscape watering of municipal parks, golf courses and athletic fields is prohibited. Variances may be granted by the water provider under special circumstances.

  Exceptions:

  - Golf course greens and tee boxes may be watered by hand, as necessary.
  - Variances may be available for watering of athletic fields (field only, does not include surrounding landscaped areas) used for organized sports practice, competition, or exhibition events to protect the health and safety of the players, staff, or officials present for the athletic event.
- Professional and college sports fields (playing fields with a stadium only – not surrounding landscaping) may be watered as necessary to maintain league standards.

- Require hotels, restaurant, and bars to serve drinking water to patrons on an "on demand" basis.
- Require hotels to implement laundry conservation measures by encouraging patrons to reuse linens and towels.
- Stock at commercial plant nursery may be watered by hand only with a handheld hose, hand-held watering can, soaker hose, or drip irrigation system.
- Commercial and industrial water users may be required to reduce water use by a set percentage as determined by the Water District.

11.6 Procedure for Curtailment of Water Supplies

Any mandatory reduction to deliveries from TRWD to its customers shall be distributed as required by Texas Water Code §11.039, which is attached as Appendix N. In addition, every wholesale water supply contract entered into or renewed after adoption of this plan, including contract extensions, shall include a provision that water will be distributed in accordance with the Texas Water Code §11.039 in case of a water shortage resulting from drought.

To the extent not prevented by enforcement of provisions in the Water District's wholesale contracts in effect before November 28, 1999, TRWD will implement pro rata curtailment of water deliveries pursuant to Texas Water Code §11.039.

11.7 Procedure for Granting Variances to the Plan

The General Manager may grant temporary variances for existing water uses otherwise prohibited under this drought contingency plan to a customer if one or more of the following conditions are met:

- Failure to grant such a variance would cause an emergency condition adversely affecting health, sanitation, or fire safety for the public or the person requesting the variance.
- Compliance with this plan cannot be accomplished due to technical or other limitations.
- Alternative methods that achieve the same level of reduction in water use can be implemented.

Variances shall be granted or denied at the discretion of the General Manager. All petitions for variances should be in writing and should include the following information:

- Name and address of petitioner(s)
- Purpose of water use
- Specific provisions from which relief is requested
- Detailed statement of the adverse effect of the provision from which relief is requested

- Description of the relief requested
- Period of time for which the variance is sought
- Alternative measures that will be taken to reduce water use
- Other pertinent information.

11.8 Procedure for Enforcing Mandatory Water Restrictions

Water District customers (direct and indirect) shall provide TRWD with an order, ordinance, or resolution to demonstrate adequate enforcement provisions for the customer's own drought contingency plan.

Mandatory water use restrictions may be imposed in Stage 1, Stage 2, and Stage 3 drought stages. These mandatory water use restrictions will be enforced by warnings and penalties as follows:

- On the first violation, the customer will be given a written warning that they have violated one or more of the mandatory water use restrictions.
- After a second violation, TRWD will notify the customer of its intent to publish the name and contact phone numbers of any entity in violation of this water conservation and drought contingency plan in local print media and on its Web site. In addition, TRWD will require the customer to implement a more comprehensive public education and outreach program in a manner that increases the public's awareness about mandatory water use restrictions and the current drought status. The customer will also be required to submit documentation to TRWD of the steps it has taken to ensure compliance with this water conservation and drought contingency plan within 90 days after receiving the second notice of violation.
- TRWD may petition the Texas Commission on Environmental Quality to initiate formal enforcement action against customers that repeatedly fail to comply with the mandatory water use restrictions implemented during any stage of this water conservation and drought contingency plan.

11.9 Coordination with the Regional Water Planning Groups

Appendix L includes copies of letters sent to the Chairs of the Region C and Region D water planning group with this water conservation and drought contingency plan.

11.10 Review and Update of Drought Contingency Plan

As required by TCEQ rules, TRWD reviewed this drought contingency plan in 2014 and will do so every five years thereafter. The plan will be updated as appropriate based on new or updated information.

11.11 Drought Contingency Plan Definitions

Term	Definition
Aesthetic Water Use	Water use for ornamental or decorative features, such as fountains, reflecting pools, and water gardens.
Alternative Water Source	Water produced by a source other than a water treatment plant and is not considered potable. These sources can include, but are not limited to: reclaimed/recycled water, collected rain water, collected grey water, private well water.
Athletic field	A sports playing field, the essential feature of which is turf grass, used primarily for organized sports for schools, professional sports, or sanctioned league play.
Automatic Irrigation System	A site specific system of delivering water generally for landscaping via a system of pipes or other conduits installed below ground that automatically cycles water use through water emitters to a preset program, whether on a designated timer or through manual operation.
Aquatic Life	A vertebrate organism dependent upon an aquatic environment to sustain its life.
Conservation	Those practices, techniques, and technologies that reduce water consumption; reduce the loss or waste of water; improve the efficiency in water use; and increase the recycling and reuse of water so that supply is conserved and made available for other or future uses.
Customer	Any person, company, or organization using water supplied by TRWD or through an entity supplied by TRWD.
Drip irrigation	An irrigation system (drip, porous pipe, etc.) that applies water at a predetermined controlled low-flow levels directly to the roots of the plant
Drought Contingency Plan	A strategy or combination of strategies for temporary supply management and demand management responses to temporary or potentially recurring water supply shortages and other water supply emergencies.

Term	**Definition**
Fountain	An artificially created jet, stream or flow of water, a structure, often decorative, from which a jet, stream or flow of water issues.
Golf Course	An irrigated and landscaped playing area made up of greens, tees, fairways, roughs and related areas used for the playing of golf.
Hand-held hose	A hose physically held by one person, fitted with a manual or automatic shutoff nozzle.
Hose-end Sprinkler	A device through which water flows from a hose to a sprinkler to water any lawn or landscape.
Hosing	To spray, water, or wash with a water hose.
Irrigation system	A system of fixed pipes and water emitters that apply water to landscape plants or turfgrass, including, but not limited to: in-ground and permanent irrigation systems.
Lake, lagoon, or pond	Artificially created body of fresh or salt water.
Landscape irrigation use	Water used for the irrigation and maintenance of landscaped areas, whether publicly or privately owned, including residential and commercial lawns, gardens, golf courses, parks, right-of-ways, medians and entry ways.
"New landscape"	A landscape: a. Installed during construction of a new house, multi-family dwelling, or commercial building; b. Installed as part of a governmental entity's capital improvement project; or Alters more than one-third the area of an existing landscape.

Term	**Definition**
Non-essential water use	Water uses that are not required for the protection of public health, safety and welfare, such as: a. Irrigating landscape areas, including parks, athletic fields, and golf courses, except as otherwise provided under this plan; b. Washing any sidewalks, walkways, driveways, parking lots, tennis courts, or other hard-surfaced areas; except to alleviate a public health and safety issue; c. Washing any automobile, motorbike, boat (and/or trailer), airplane, or other vehicle except where required by law for safety and sanitary purposes. d. Washing buildings or structures for purposes other than immediate fire protection, or other uses provided under this plan; e. Filling, refilling, or adding to any swimming pools or Jacuzzi-type pools, except to maintain safe operating levels; f. Filling or operation of a fountain or pond for aesthetic or scenic purposes except when necessary to support aquatic life; g. Failure to repair a controllable leak within a reasonable time period after being directed to do so by formal notice; and h. Drawing from hydrants for construction purposes or any other purpose other than firefighting or protection of public drinking water supplies.
Park	A non-residential or multifamily tract of land, other than a golf course, maintained by a city, private organization, or individual, as a place of beauty or public recreation and available for use to the general public.
Power/Pressure washer	A machine that uses water or a water-based product applied at high pressure to clean impervious surfaces.
Power/Pressure washer (High-Efficiency)	A machine that uses water or a water-based product applied at 1500 pounds per square inch (PSI) or greater.

Term	**Definition**
Reclaimed Water	Municipal wastewater effluent that is given additional treatment and distributed for reuse in certain applications. Also referred to as recycled water.
Soaker hose	A flexible hose that is designed to slowly emit water across the entire length and connect directly to a flexible hose or spigot. Does not include hose that by design or use sends a fine spray in the air. It is not considered drip irrigation.
Structural Foundation	The lowest and supporting layer of a structure.
Swimming pool	Any structure, basin, chamber, or tank including hot tubs, containing an artificial body of water for swimming, diving, or recreational bathing, and having a depth of two (2) feet or more at any point.
Well Water	Water that has been, or is, obtained from the ground by digging, boring, or drilling to access an underground aquifer.

APPENDIX A
LIST OF REFERENCES

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Appendix A

List of References

(1) Title 30 of the Texas Administrative Code, Part 1, Chapter 288, Subchapter A, Rules 288.1, 288.2 and 288.5, downloaded from http://info.sos.state.tx.us/pls/pub/readtac$ext.ViewTAC?tac_view=5&ti=30&pt=1&ch=288&sch=A&rl=Y , May 2014.

(2) Title 30 of the Texas Administrative Code, Part 1, Chapter 288, Subchapter B, Rule 288.20 and 288.22, downloaded from http://info.sos.state.tx.us/pls/pub/readtac$ext.ViewTAC?tac_view=5&ti=30&pt=1&ch=288&sch=B&rl=Y , May 2014.

(3) Texas Water Development Board, Report 362, "Water Conservation Best Management Practices Guide," Water Conservation Implementation Task Force, available online at http://www.twdb.state.tx.us/assistance/conservation/TaskForceDocs/WCITFBMPGuide.pdf, November 2004.

(4) Edward Motley, Marisa Vergara, Tom Gooch, and Stephanie Griffin: Memorandum to File on "Region C Municipal Water Use Projections Adopted on August 18, 2003," Fort Worth, August 21, 2003.

(5) North Central Texas Council of Governments, "2014 Current Population Estimates," Arlington, available through the Cooperative Data Program: www.nctcorg/ris/cdp/aboutus.aspx , April 2014.

(6) Texas Water Development Board and Water Conservation Implementation Task Force, "Special Report, Report to the 79th Legislature, Austin, available online http://www.twdb.state.tx.us/assistance/conservation/TaskForceDocs/WCITF_Leg_Report.pdf, November 2004.

This water conservation and drought contingency plan was largely adapted from the following two plans:

a. North Texas Municipal Water District: "Water Conservation and Drought Contingency Plan," prepared by Freese and Nichols, Inc., Fort Worth, August 2004 with revisions in April 2006.

b. Tarrant Regional Water District: "Water Conservation and Drought Contingency Plan," originally developed by HDR Engineering, Inc., Austin, June 1998 and updated by TRWD in April 2005.

The following conservation and drought contingency plans and related documents were reviewed in the development of the North Texas Municipal Water District (NTMWD) plan cited above. References marked with a * were used heavily in the development of the NTMWD plan.

c. City of Austin Water Conservation Division: "City of Austin Water Drought Contingency Plan, Developed to Meet Senate Bill 1 Regulatory Requirements," Austin, August 1999.

d. City of Austin Water Conservation Division: "City of Austin Water Conservation Plan, Developed to Meet Senate Bill 1 Regulatory Requirements," Austin, August 1999.

e. Upper Trinity Regional Water District: "Water Conservation Plan and Emergency Water Demand Management Plan," adopted by the Board of Directors, Lewisville, August 5, 1999.

f. Upper Trinity Regional Water District: "Water Conservation Plan and Emergency Water Demand Management Plan (2002 Amended)," adopted by the Board of Directors, Lewisville, February 2002.

g. *City of Dallas Water Utilities Department: "City of Dallas Water Management Plan," adopted by the City Council, Dallas, September 1999.

h. Updates to City of Dallas Water Management Plan found at http://www.dallascityhall.com in September 2003.

i. City of Dallas Water Utilities Department: "City of Dallas Water Conservation Plan," adopted by the City Council, Dallas, September 1999.

j. City of Fort Worth: "Water Conservation plan for the City of Fort Worth," Fort Worth, August 1999.

k. Updates to the City of Fort Worth water conservation plan found at http://ci./fort-worth.tx.us in September 2003.

l. *City of Fort Worth: "Emergency Water Management Plan for the City of Fort Worth," Fort Worth, August 19, 2003.

m. HDR Engineering, Inc.: "Water Conservation and Emergency Demand Management Plan," prepared for the Tarrant Regional Water District, Austin, February 2000.

n. Freese and Nichols, Inc.: "Water Conservation and Drought Contingency Plan," prepared for Brown County Water Improvement District No. 1, Fort Worth, August 1999.

o. Freese and Nichols, Inc.: "Water Conservation and Drought Contingency Plan," prepared for the Sabine River Authority of Texas, Fort Worth, September 1994.

p. HDR Engineering, Inc.: "Water Conservation and Emergency Demand Management Plan," prepared for the Tarrant Regional Water District, Austin, June 1998.

q. HDR Engineering, Inc.: "Water Conservation Plan for the City of Corpus Christi," adopted by the City of Corpus Christi City Council, August 24, 1999.

r. City of Houston's water conservation plan downloaded September 2003 from http://www.cityofhouston.gov

s. City of Houston: "Ordinance N. 2001-753, Amending Chapter 47 of the Code of Ordinances Relating to Water Emergencies," Houston, August 2001.

t. City of Houston: "Ordinance No. 98-764, Relating to Water Conservation," Houston, September 1998.

u. City of Houston: "Water Conservation Plan," 1998.

v. City of Houston: "Water Emergency Response Plan," Houston, July 15, 1998.

w. City of Lubbock: "Water Conservation Plan," ordinance number 10177 adopted by the City Council in August 1999.

x. City of El Paso Water Conservation Ordinance downloaded August 14, 2003 from http://www.epwu.org/ordinance.html

y. San Antonio Water System: "Water Conservation and Reuse Plan," San Antonio, November 1998 with June 2002 updates.

z. *North Texas Municipal Water District: "District Policy No. 24 Water Conservation Plan Containing Drought Contingency Plan," adopted August 1999.

aa. GDS Associates, Inc.: "Water Conservation Study," prepared for the Texas Water Development Board, Fort Worth, 2002.

bb. A & N Technical Services, Inc.: "BMP Costs & Savings Study: A Guide to Data and Methods for Cost-Effectiveness Analysis of Urban Water Conservation Best Management Practices," prepared for The California Urban Water Conservation Council, Santa Monica, California, July 2000.

cc. City of Dallas: "City of Dallas Ordinances, Chapter 49, Section 21.1," Dallas, October 1, 2001.

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APPENDIX B

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY RULES ON WATER CONSERVATION AND DROUGHT CONTINGENCY PLANS FOR MUNICIPAL AND WHOLESALE WATER PROVIDERS

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APPENDIX B

Texas Commission on Environmental Quality Rules on Water Conservation and Drought Contingency Plans for Wholesale Water Suppliers

Texas Administrative Code

TITLE 30	ENVIRONMENTAL QUALITY
PART 1	TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
CHAPTER 288	WATER CONSERVATION PLANS, DROUGHT CONTINGENCY PLANS, GUIDELINES AND REQUIREMENTS
SUBCHAPTER A	WATER CONSERVATION PLANS
RULE §288.1	**Definitions**

The following words and terms, when used in this chapter, shall have the following meanings, unless the context clearly indicates otherwise.

(1) Agricultural or Agriculture--Any of the following activities:

(A) cultivating the soil to produce crops for human food, animal feed, or planting seed or for the production of fibers;

(B) the practice of floriculture, viticulture, silviculture, and horticulture, including the cultivation of plants in containers or non-soil media by a nursery grower;

(C) raising, feeding, or keeping animals for breeding purposes or for the production of food or fiber, leather, pelts, or other tangible products having a commercial value;

(D) raising or keeping equine animals;

(E) wildlife management; and

(F) planting cover crops, including cover crops cultivated for transplantation, or leaving land idle for the purpose of participating in any governmental program or normal crop or livestock rotation procedure.

(2) Agricultural use--Any use or activity involving agriculture, including irrigation.

(3) Best management practices--Voluntary efficiency measures that save a quantifiable amount of water, either directly or indirectly, and that can be implemented within a specific time frame.

(4) Conservation--Those practices, techniques, and technologies that reduce the consumption of water, reduce the loss or waste of water, improve the efficiency in the use of water, or increase the recycling and reuse of water so that a water supply is made available for future or alternative uses.

(5) Commercial use--The use of water by a place of business, such as a hotel, restaurant, or office building. This does not include multi-family residences or agricultural, industrial, or institutional users.

(6) Drought contingency plan--A strategy or combination of strategies for temporary supply and demand management responses to temporary and potentially recurring water supply shortages and other water supply emergencies. A drought contingency plan may be a separate document identified as such or may be contained within another water management document(s).

(7) Industrial use--The use of water in processes designed to convert materials of a lower order of value into forms having greater usability and commercial value, and the development of power by means other than hydroelectric, but does not include agricultural use.

(8) Institutional use--The use of water by an establishment dedicated to public service, such as a school, university, church, hospital, nursing home, prison or government facility. All facilities dedicated to public service are considered institutional regardless of ownership.

(9) Irrigation--The agricultural use of water for the irrigation of crops, trees, and pastureland, including, but not limited to, golf courses and parks which do not receive water from a public water supplier.

(10) Irrigation water use efficiency--The percentage of that amount of irrigation water which is beneficially used by agriculture crops or other vegetation relative to the amount of water diverted from the source(s) of supply. Beneficial uses of water for irrigation purposes include, but are not limited to, evapotranspiration needs for vegetative maintenance and growth, salinity management, and leaching requirements associated with irrigation.

(11) Mining use--The use of water for mining processes including hydraulic use, drilling, washing sand and gravel, and oil field re-pressuring.

(12) Municipal use--The use of potable water provided by a public water supplier as well as the use of sewage effluent for residential, commercial, industrial, agricultural, institutional, and wholesale uses.

(13) Nursery grower--A person engaged in the practice of floriculture, viticulture, silviculture, and horticulture, including the cultivation of plants in containers or nonsoil media, who grows more than 50% of the products that the person either sells or leases, regardless of the variety sold, leased, or grown. For the purpose of this definition, grow means the actual cultivation or propagation of the product beyond the mere holding or maintaining of the item prior to sale or lease, and typically includes activities associated with the production or multiplying of stock such as the development of new plants from cuttings, grafts, plugs, or seedlings.

(14) Pollution--The alteration of the physical, thermal, chemical, or biological quality of, or the contamination of, any water in the state that renders the water harmful, detrimental, or injurious to humans, animal life, vegetation, or property, or to the public health, safety, or welfare, or impairs the usefulness or the public enjoyment of

the water for any lawful or reasonable purpose.

(15) Public water supplier--An individual or entity that supplies water to the public for human consumption.

(16) Residential use--The use of water that is billed to single and multi-family residences, which applies to indoor and outdoor uses.

(17) Residential gallons per capita per day--The total gallons sold for residential use by a public water supplier divided by the residential population served and then divided by the number of days in the year.

(18) Regional water planning group--A group established by the Texas Water Development Board to prepare a regional water plan under Texas Water Code, §16.053.

(19) Retail public water supplier--An individual or entity that for compensation supplies water to the public for human consumption. The term does not include an individual or entity that supplies water to itself or its employees or tenants when that water is not resold to or used by others.

(20) Reuse--The authorized use for one or more beneficial purposes of use of water that remains unconsumed after the water is used for the original purpose of use and before that water is either disposed of or discharged or otherwise allowed to flow into a watercourse, lake, or other body of state-owned water.

(21) Total use--The volume of raw or potable water provided by a public water supplier to billed customer sectors or nonrevenue uses and the volume lost during conveyance, treatment, or transmission of that water.

(22) Total gallons per capita per day (GPCD)--The total amount of water diverted and/or pumped for potable use divided by the total permanent population divided by the days of the year. Diversion volumes of reuse as defined in this chapter shall be credited against total diversion volumes for the purposes of calculating GPCD for targets and goals.

(23) Water conservation plan--A strategy or combination of strategies for reducing the volume of water withdrawn from a water supply source, for reducing the loss or waste of water, for maintaining or improving the efficiency in the use of water, for increasing the recycling and reuse of water, and for preventing the pollution of water. A water conservation plan may be a separate document identified as such or may be contained within another water management document(s).

(24) Wholesale public water supplier--An individual or entity that for compensation supplies water to another for resale to the public for human consumption. The term does not include an individual or entity that supplies water to itself or its employees or tenants as an incident of that employee service or tenancy when that water is not resold to or used by others, or an individual or entity that conveys water to another individual or entity, but does not own the right to the water which is conveyed, whether or not for a delivery fee.

(25) Wholesale use--Water sold from one entity or public water supplier to other retail

water purveyors for resale to individual customers.

Source Note: The provisions of this §288.1 adopted to be effective May 3, 1993, 18 TexReg 2558; amended to be effective February 21, 1999, 24 TexReg 949; amended to be effective April 27, 2000, 25 TexReg 3544; amended to be effective August 15, 2002, 27 TexReg 7146; amended to be effective October 7, 2004, 29 TexReg 9384; amended to be effective January 10, 2008, 33 TexReg 193; amended to be effective December 6, 2012, 37 TexReg 9515

Texas Administrative Code

TITLE 30	ENVIRONMENTAL QUALITY
PART 1	TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
CHAPTER 288	WATER CONSERVATION PLANS, DROUGHT CONTINGENCY PLANS, GUIDELINES AND REQUIREMENTS
SUBCHAPTER A	WATER CONSERVATION PLANS
RULE §288.2	**Water Conservation Plans for Municipal Uses by Public Water Suppliers**

(a) A water conservation plan for municipal water use by public water suppliers must provide information in response to the following. If the plan does not provide information for each requirement, the public water supplier shall include in the plan an explanation of why the requirement is not applicable.

(1) Minimum requirements. All water conservation plans for municipal uses by public water suppliers must include the following elements:

(A) a utility profile in accordance with the Texas Water Use Methodology, including, but not limited to, information regarding population and customer data, water use data (including total gallons per capita per day (GPCD) and residential GPCD), water supply system data, and wastewater system data;

(B) a record management system which allows for the classification of water sales and uses into the most detailed level of water use data currently available to it, including, if possible, the sectors listed in clauses (i) - (vi) of this subparagraph. Any new billing system purchased by a public water supplier must be capable of reporting detailed water use data as described in clauses (i) - (vi) of this subparagraph:

(i) residential;

(I) single family;

(II) multi-family;

(ii) commercial;

(iii) institutional;

(iv) industrial;

(v) agricultural; and,

(vi) wholesale.

(C) specific, quantified five-year and ten-year targets for water savings to include goals for water loss programs and goals for municipal use in total GPCD and residential GPCD. The goals established by a public water supplier under this subparagraph are not enforceable;

(D) metering device(s), within an accuracy of plus or minus 5.0% in order to

measure and account for the amount of water diverted from the source of supply;

(E) a program for universal metering of both customer and public uses of water, for meter testing and repair, and for periodic meter replacement;

(F) measures to determine and control water loss (for example, periodic visual inspections along distribution lines; annual or monthly audit of the water system to determine illegal connections; abandoned services; etc.);

(G) a program of continuing public education and information regarding water conservation;

(H) a water rate structure which is not "promotional," i.e., a rate structure which is cost-based and which does not encourage the excessive use of water;

(I) a reservoir systems operations plan, if applicable, providing for the coordinated operation of reservoirs owned by the applicant within a common watershed or river basin in order to optimize available water supplies; and

(J) a means of implementation and enforcement which shall be evidenced by:

(i) a copy of the ordinance, resolution, or tariff indicating official adoption of the water conservation plan by the water supplier; and

(ii) a description of the authority by which the water supplier will implement and enforce the conservation plan; and

(K) documentation of coordination with the regional water planning groups for the service area of the public water supplier in order to ensure consistency with the appropriate approved regional water plans.

(2) Additional content requirements. Water conservation plans for municipal uses by public drinking water suppliers serving a current population of 5,000 or more and/or a projected population of 5,000 or more within the next ten years subsequent to the effective date of the plan must include the following elements:

(A) a program of leak detection, repair, and water loss accounting for the water transmission, delivery, and distribution system;

(B) a requirement in every wholesale water supply contract entered into or renewed after official adoption of the plan (by either ordinance, resolution, or tariff), and including any contract extension, that each successive wholesale customer develop and implement a water conservation plan or water conservation measures using the applicable elements in this chapter. If the customer intends to resell the water, the contract between the initial supplier and customer must provide that the contract for the resale of the water must have water conservation requirements so that each successive customer in the resale of the water will be required to implement water conservation measures in accordance with the provisions of this chapter.

(3) Additional conservation strategies. Any combination of the following strategies shall be selected by the water supplier, in addition to the minimum requirements in paragraphs (1) and (2) of this subsection, if they are necessary to achieve the

stated water conservation goals of the plan. The commission may require that any of the following strategies be implemented by the water supplier if the commission determines that the strategy is necessary to achieve the goals of the water conservation plan:

(A) conservation-oriented water rates and water rate structures such as uniform or increasing block rate schedules, and/or seasonal rates, but not flat rate or decreasing block rates;

(B) adoption of ordinances, plumbing codes, and/or rules requiring water-conserving plumbing fixtures to be installed in new structures and existing structures undergoing substantial modification or addition;

(C) a program for the replacement or retrofit of water-conserving plumbing fixtures in existing structures;

(D) reuse and/or recycling of wastewater and/or graywater;

(E) a program for pressure control and/or reduction in the distribution system and/or for customer connections;

(F) a program and/or ordinance(s) for landscape water management;

(G) a method for monitoring the effectiveness and efficiency of the water conservation plan; and

(H) any other water conservation practice, method, or technique which the water supplier shows to be appropriate for achieving the stated goal or goals of the water conservation plan.

(b) A water conservation plan prepared in accordance with 31 TAC §363.15 (relating to Required Water Conservation Plan) of the Texas Water Development Board and substantially meeting the requirements of this section and other applicable commission rules may be submitted to meet application requirements in accordance with a memorandum of understanding between the commission and the Texas Water Development Board.

(c) A public water supplier for municipal use shall review and update its water conservation plan, as appropriate, based on an assessment of previous five-year and ten-year targets and any other new or updated information. The public water supplier for municipal use shall review and update the next revision of its water conservation plan every five years to coincide with the regional water planning group.

Source Note: The provisions of this §288.2 adopted to be effective May 3, 1993, 18 TexReg 2558; amended to be effective February 21, 1999, 24 TexReg 949; amended to be effective April 27, 2000, 25 TexReg 3544; amended to be effective October 7, 2004, 29 TexReg 9384; amended to be effective December 6, 2012, 37 TexReg 9515

Texas Administrative Code

TITLE 30	ENVIRONMENTAL QUALITY
PART 1	TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
CHAPTER 288	WATER CONSERVATION PLANS, DROUGHT CONTINGENCY PLANS, GUIDELINES AND REQUIREMENTS
SUBCHAPTER A	WATER CONSERVATION PLANS
RULE §288.5	**Water Conservation Plans for Wholesale Water Suppliers**

A water conservation plan for a wholesale water supplier must provide information in response to each of the following paragraphs. If the plan does not provide information for each requirement, the wholesale water supplier shall include in the plan an explanation of why the requirement is not applicable.

(1) Minimum requirements. All water conservation plans for wholesale water suppliers must include the following elements:

(A) a description of the wholesaler's service area, including population and customer data, water use data, water supply system data, and wastewater data;

(B) specific, quantified five-year and ten-year targets for water savings including, where appropriate, target goals for municipal use in gallons per capita per day for the wholesaler's service area, maximum acceptable water loss, and the basis for the development of these goals. The goals established by wholesale water suppliers under this subparagraph are not enforceable;

(C) a description as to which practice(s) and/or device(s) will be utilized to measure and account for the amount of water diverted from the source(s) of supply;

(D) a monitoring and record management program for determining water deliveries, sales, and losses;

(E) a program of metering and leak detection and repair for the wholesaler's water storage, delivery, and distribution system;

(F) a requirement in every water supply contract entered into or renewed after official adoption of the water conservation plan, and including any contract extension, that each successive wholesale customer develop and implement a water conservation plan or water conservation measures using the applicable elements of this chapter. If the customer intends to resell the water, then the contract between the initial supplier and customer must provide that the contract for the resale of the water must have water conservation requirements so that each successive customer in the resale of the water will be required to implement water conservation measures in accordance with applicable provisions of this chapter;

(G) a reservoir systems operations plan, if applicable, providing for the coordinated operation of reservoirs owned by the applicant within a common watershed or

river basin. The reservoir systems operations plans shall include optimization of water supplies as one of the significant goals of the plan;

(H) a means for implementation and enforcement, which shall be evidenced by a copy of the ordinance, rule, resolution, or tariff, indicating official adoption of the water conservation plan by the water supplier; and a description of the authority by which the water supplier will implement and enforce the conservation plan; and

(I) documentation of coordination with the regional water planning groups for the service area of the wholesale water supplier in order to ensure consistency with the appropriate approved regional water plans.

(2) Additional conservation strategies. Any combination of the following strategies shall be selected by the water wholesaler, in addition to the minimum requirements of paragraph (1) of this section, if they are necessary in order to achieve the stated water conservation goals of the plan. The commission may require by commission order that any of the following strategies be implemented by the water supplier if the commission determines that the strategies are necessary in order for the conservation plan to be achieved:

(A) conservation-oriented water rates and water rate structures such as uniform or increasing block rate schedules, and/or seasonal rates, but not flat rate or decreasing block rates;

(B) a program to assist agricultural customers in the development of conservation pollution prevention and abatement plans;

(C) a program for reuse and/or recycling of wastewater and/or graywater; and

(D) any other water conservation practice, method, or technique which the wholesaler shows to be appropriate for achieving the stated goal or goals of the water conservation plan.

(3) Review and update requirements. The wholesale water supplier shall review and update its water conservation plan, as appropriate, based on an assessment of previous five-year and ten-year targets and any other new or updated information. A wholesale water supplier shall review and update the next revision of its water conservation plan every five years to coincide with the regional water planning group.

Source Note: The provisions of this §288.5 adopted to be effective May 3, 1993, 18 TexReg 2558; amended to be effective February 21, 1999, 24 TexReg 949; amended to be effective April 27, 2000, 25 TexReg 3544; amended to be effective October 7, 2004, 29 TexReg 9384; amended to be effective December 6, 2012, 37 TexReg 9515

Texas Administrative Code

TITLE 30	ENVIRONMENTAL QUALITY
PART 1	TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
CHAPTER 288	WATER CONSERVATION PLANS, DROUGHT CONTINGENCY PLANS, GUIDELINES AND REQUIREMENTS
SUBCHAPTER B	DROUGHT CONTINGENCY PLANS
RULE §288.20	**Drought Contingency Plans for Municipal Uses by Public Water Suppliers**

(a) A drought contingency plan for a retail public water supplier, where applicable, must include the following minimum elements.

(1) Minimum requirements. Drought contingency plans must include the following minimum elements.

(A) Preparation of the plan shall include provisions to actively inform the public and affirmatively provide opportunity for public input. Such acts may include, but are not limited to, having a public meeting at a time and location convenient to the public and providing written notice to the public concerning the proposed plan and meeting.

(B) Provisions shall be made for a program of continuing public education and information regarding the drought contingency plan.

(C) The drought contingency plan must document coordination with the Regional Water Planning Groups for the service area of the retail public water supplier to insure consistency with the appropriate approved regional water plans.

(D) The drought contingency plan must include a description of the information to be monitored by the water supplier, and specific criteria for the initiation and termination of drought response stages, accompanied by an explanation of the rationale or basis for such triggering criteria.

(E) The drought contingency plan must include drought or emergency response stages providing for the implementation of measures in response to at least the following situations:

(i) reduction in available water supply up to a repeat of the drought of record;

(ii) water production or distribution system limitations;

(iii) supply source contamination; or

(iv) system outage due to the failure or damage of major water system components (e.g., pumps).

(F) The drought contingency plan must include specific, quantified targets for water use reductions to be achieved during periods of water shortage and drought. The entity preparing the plan shall establish the targets. The goals established by the entity under this subparagraph are not enforceable.

(G) The drought contingency plan must include the specific water supply or water demand management measures to be implemented during each stage of the plan including, but not limited to, the following:

(i) curtailment of non-essential water uses; and

(ii) utilization of alternative water sources and/or alternative delivery mechanisms with the prior approval of the executive director as appropriate (e.g., interconnection with another water system, temporary use of a non-municipal water supply, use of reclaimed water for non-potable purposes, etc.).

(H) The drought contingency plan must include the procedures to be followed for the initiation or termination of each drought response stage, including procedures for notification of the public.

(I) The drought contingency plan must include procedures for granting variances to the plan.

(J) The drought contingency plan must include procedures for the enforcement of any mandatory water use restrictions, including specification of penalties (e.g., fines, water rate surcharges, discontinuation of service) for violations of such restrictions.

(2) Privately-owned water utilities. Privately-owned water utilities shall prepare a drought contingency plan in accordance with this section and incorporate such plan into their tariff.

(3) Wholesale water customers. Any water supplier that receives all or a portion of its water supply from another water supplier shall consult with that supplier and shall include in the drought contingency plan appropriate provisions for responding to reductions in that water supply.

(b) A wholesale or retail water supplier shall notify the executive director within five business days of the implementation of any mandatory provisions of the drought contingency plan.

(c) The retail public water supplier shall review and update, as appropriate, the drought contingency plan, at least every five years, based on new or updated information, such as the adoption or revision of the regional water plan.

Source Note: The provisions of this §288.20 adopted to be effective February 21, 1999, 24 TexReg 949; amended to be effective April 27, 2000, 25 TexReg 3544; amended to be effective October 7, 2004, 29 TexReg 9384

Texas Administrative Code

TITLE 30	ENVIRONMENTAL QUALITY
PART 1	TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
CHAPTER 288	WATER CONSERVATION PLANS, DROUGHT CONTINGENCY PLANS, GUIDELINES AND REQUIREMENTS
SUBCHAPTER B	DROUGHT CONTINGENCY PLANS
RULE §288.22	**Drought Contingency Plans for Wholesale Water Suppliers**

(a) A drought contingency plan for a wholesale water supplier must include the following minimum elements.

(1) Preparation of the plan shall include provisions to actively inform the public and to affirmatively provide opportunity for user input in the preparation of the plan and for informing wholesale customers about the plan. Such acts may include, but are not limited to, having a public meeting at a time and location convenient to the public and providing written notice to the public concerning the proposed plan and meeting.

(2) The drought contingency plan must document coordination with the regional water planning groups for the service area of the wholesale public water supplier to insure consistency with the appropriate approved regional water plans.

(3) The drought contingency plan must include a description of the information to be monitored by the water supplier and specific criteria for the initiation and termination of drought response stages, accompanied by an explanation of the rationale or basis for such triggering criteria.

(4) The drought contingency plan must include a minimum of three drought or emergency response stages providing for the implementation of measures in response to water supply conditions during a repeat of the drought-of-record.

(5) The drought contingency plan must include the procedures to be followed for the initiation or termination of drought response stages, including procedures for notification of wholesale customers regarding the initiation or termination of drought response stages.

(6) The drought contingency plan must include specific, quantified targets for water use reductions to be achieved during periods of water shortage and drought. The entity preparing the plan shall establish the targets. The goals established by the entity under this paragraph are not enforceable.

(7) The drought contingency plan must include the specific water supply or water demand management measures to be implemented during each stage of the plan including, but not limited to, the following:

(A) pro rata curtailment of water deliveries to or diversions by wholesale water customers as provided in Texas Water Code, §11.039; and

(B) utilization of alternative water sources with the prior approval of the executive director as appropriate (e.g., interconnection with another water system, temporary use of a non-municipal water supply, use of reclaimed water for non-potable purposes, etc.).

(8) The drought contingency plan must include a provision in every wholesale water contract entered into or renewed after adoption of the plan, including contract extensions, that in case of a shortage of water resulting from drought, the water to be distributed shall be divided in accordance with Texas Water Code, §11.039.

(9) The drought contingency plan must include procedures for granting variances to the plan.

(10) The drought contingency plan must include procedures for the enforcement of any mandatory water use restrictions including specification of penalties (e.g., liquidated damages, water rate surcharges, discontinuation of service) for violations of such restrictions.

(b) The wholesale public water supplier shall notify the executive director within five business days of the implementation of any mandatory provisions of the drought contingency plan.

(c) The wholesale public water supplier shall review and update, as appropriate, the drought contingency plan, at least every five years, based on new or updated information, such as adoption or revision of the regional water plan.

Source Note: The provisions of this §288.22 adopted to be effective February 21, 1999, 24 TexReg 949; amended to be effective April 27, 2000, 25 TexReg 3544; amended to be effective October 7, 2004, 29 TexReg 9384

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APPENDIX C

TARRANT REGIONAL WATER DISTRICT
WHOLESALE PUBLIC WATER SUPPLIER PROFILE
BASED ON TCEQ FORMAT

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Appendix C

Tarrant Regional Water District Wholesale Public Water Supplier Profile Based on TCEQ Format

Name of Entity:	Tarrant Regional Water District
Address & Zip:	800 East Northside Drive
Telephone Number:	(817) 335-2491 **Fax:** (817) 877-5137
Water Right No.(s):	TCEQ Reg Entity #: RN102904463,
	TCEQ Cust #: CN602719957
Form Completed by:	Laura Blaylock
Title:	Hydrologist
Persons responsible for implementing conservation program:	Mark Olson Phone: (817) 335-2491 Dean Minchillo Phone: (817) 335-2491
Signature:	Date: May 1, 2014

NOTE: If the plan does not provide information for each requirement, include an explanation of why the requirement is not applicable.

PROFILE

I. WHOLESALE SERVICE AREA POPULATION AND CUSTOMER DATA

A. *Population and Service Area Data, 1-3*

Service area size (in square miles): (Please attach copy of service area map)	5,891
Current Population of Service Area (2013)	1,817,900
Current Population Served For:	
a. Water	1,817,900
b. Wastewater	TRWD does not provide any wastewater treatment

4. Population served for previous five years

2009	1,796,405
2010	1,771,443
2011	1,781,735
2012	1,795,707
2013	1,817,900

5. Projected population for service area in following decades

Year	Population Projections of Existing Customers	Population Projections including Potential Future Customers
2020	2,231,578	2,240,483
2030	2,603,534	2,637,546
2040	3,021,266	3,068,046
2050	3,438,944	3,506,895
2060	3,889,311	3,992,417
2070	4,408,280	4,574,167

6. Source method for the calculation of current and projected population

Population projections from the 2016 Region C Water Plan were used as a reference point for service area population. The percentage of populations within each county that is served by TRWD is based on information provided by Region C Water Planning Group (RCWPG).

Region C estimates have consistently trended significantly higher than historical data. Comparing historical numbers with population projections in 2010 shows the extent of the errant population numbers produced by RCWPG. The difference between the projected and historical population in 2010 represents an overestimation of 43 percent. One reason for this discrepancy in population numbers is Region C includes the entire population of communities served by TRWD, even though the communities may have other water supply sources, i.e. groundwater, which are used to supplement demands.

Current population (2009-2013) is estimated from data obtained from the North Central Texas Council of Governments. In communities where supplemental water supply sources are used, TRWD only accounts for the percentage of the population it serves. For instance, in Grand Prairie where the water district supplies 3.8 percent of the municipal water supply, only that portion of the population is accounted for in its population estimates.

B. Customers Data

List or attach names of all TRWD customers, amount of each annual contract, and amount of the annual use for each for the previous year:

CUSTOMER	CONTRACTUAL AMOUNT	USAGE IN 2013 (acre-feet)
City of Fort Worth (all)	All Needs	202,174
City of Arlington	All Needs	60,620
Trinity River Authority, Tarrant County Water Supply Project (TRA TCWSP)	All Needs	34,311
City of Mansfield	All Needs	10,756
City of Bridgeport	1,700	1,212
City of Waxahachie	All Needs	3,280
City of Midlothian	6,720.9	242
City of Jacksboro	263	0
City of Runaway Bay	1,120	327
Walnut Creek Water Supply Corp.	All Needs	2,160
West Wise SUD	986	355
Wise County WSD	4,000	1,536
Hanson Aggregates	1,475	0
Texas Industries, Inc.	1,200	0
Brazos Electric (Duke Energy)	4,257	4,186
Wise Co. Power Co. (Tractebel)	4,600	2,592
Trinity Materials	Temp	0
Runaway Bay Golf	124	27
The Lodge	Temp	0
Marock	Temp	0
City of Azle	1,680	1,527
Hawks' Creek Golf Club	150	193
Community Water Supply	1,851	331
City of Springtown	1,344	340
City of River Oaks	All Needs	735
The Resort Golf Club	350	120
Shady Oaks Country Club	575	141

CUSTOMER	CONTRACTUAL AMOUNT	USAGE IN 2013 (acre-feet)
The Landing	Temp	0
Tarrant County MUD	(currently not taking)	
TU Electric (Eagle Mountain Plant)	open	0
Exelon (TU electric services, Handley SES)	2,184	528
Benbrook Water Authority	All Needs	3,069
City of Weatherford	5,892	5,833
Ridglea Country Club	475.58	318
Mira Vista Country Club	568	233
FW Country Day School	153.45	22
Whitestone Golf, Ltd	400	166
Monarch/TECON (Carolynn + SW water Service)	All Needs	538
East Cedar Creek Fresh Water Supply District	All Needs	1,254
City of Kemp	600	286
City of Mabank	All Needs	981
City of Malakoff	All Needs	120
City of Star Harbor	168	85
City of Trinidad	Currently Not Taking	0
West Cedar Creek MUD	All Needs	1,330
Long Cove Ranch Co.	Temp	8
Cedar Creek Country Club	125	87
Golf Driving Range	4.6	0
Bill Sisul	Temp	2
Pinnacle Club	125	41
Tri-Stream	150	5
Winkler Water Supply Corp.	560	69
City of Corsicana	All Needs	0
Calpine/Freestone	5,602	3,305
City of Fairfield	1,680	0

II. WATER USE DATA FOR SERVICE AREA

A. Water Delivery

Indicate if the water provided under wholesale contracts is treated or raw water and the annual amount the previous five years:

All water supplied by TRWD is raw water. Data includes water provided under municipal contracts.

Year	Treated Water	Raw Water (acre-feet)
2009	n/a	331,221
2010	n/a	346,774
2011	n/a	394,034
2012	n/a	359,952
2013	n/a	334,010
Totals:	n/a	1,765,991

B. Water Accounting Data

1. Total amount of water diverted at point of diversion(s) for previous five years (in acre-feet) for all water uses:

	2009	2010	2011	2012	2013
January	21,178	21,940	25,146	22,959	22,151
February	19,465	20,166	23,112	21,102	20,359
March	21,936	22,725	26,045	23,780	22,943
April	24,152	25,021	28,676	26,183	25,261
May	28,416	29,439	33,739	30,806	29,721
June	33,181	34,375	39,397	35,972	34,705
July	40,769	42,237	48,407	44,198	42,642

	2009	2010	2011	2012	2013
August	42,688	44,224	50,685	46,278	44,648
September	34,260	35,493	40,679	37,142	35,834
October	29,036	30,081	34,475	31,478	30,369
November	23,783	24,638	28,238	25,783	24,875
December	21,733	22,515	25,804	23,561	22,731
Annual Total	340,596	352,854	404,402	369,243	356,240

2. Wholesale population served and total amount of water diverted for municipal use (in acre-feet) since 1999:

Year	Total Population Served	Total Annual Diverted for Municipal Use (acre-feet)
1999	1,412,471	268,145
2000	1,440,342	275,730
2001	1,473,172	279,052
2002	1,505,912	282,373
2003	1,538,652	285,694
2004	1,603,408	304,637
2005	1,645,901	370,942
2006	1,688,395	390,037
2007	1,725,218	306,373
2008	1,761,051	363,773
2009	1,796,405	331,221
2010	1,771,443	346,744
2011	1,781,735	394,034
2012	1,795,707	359,952
2013	1,817,900	334,010

C. Projected Water Demands

If applicable, project and attach water supply demands for the next ten years using information such as population trends, historical water use, and economic growth in the service area over the next ten years and any additional water supply requirement from such growth.

Year	Total Population Projected	Total Demands Projected (acre-feet)
2014	1,871,933	356,558
2015	1,927,572	377,531
2016	1,984,865	399,738
2017	2,043,860	423,252
2018	2,104,609	448,148
2019	2,167,164	474,509
2020	2,231,578	502,420
2021	2,266,247	509,181
2022	2,301,454	516,033
2023	2,337,208	522,978

III. WATER SUPPLY SYSTEM DATA

A. Water Supply Sources

List all current water supply sources and the amounts authorized with each:

Source*	Amount Authorized (acre-feet)
Lake Bridgeport	15,000
Eagle Mountain Lake	159,600
Cedar Creek Reservoir	175,000
Richland-Chambers Reservoir	210,000
Lake Benbrook	6,833
Reuse – Richland-Chambers	63,000
Reuse – Cedar Creek	52,500
Total permitted supply:	681,933

*All sources for TRWD are surface water. The Cedar Creek reuse project represents a future water supply source.

Permitted water supply does not reflect the amount of water TRWD can safely deliver to its customers without adversely affecting the watersheds from which the supplies originate. The following list of sources depicts firm yield capacities of TRWD's reservoir system. Firm yield of a reservoir is typically defined as the maximum yield that could be delivered without failure during the historical drought of record.

Source	**Firm Yield (acre-feet)**
Lake Bridgeport and Eagle Mountain Lake	79,000
Cedar Creek Reservoir	175,000
Richland-Chambers Reservoir	210,000
Lake Benbrook	6,833
Reuse – Richland-Chambers	63,000
Total firm yield:	533,833

B. Treatement and Distribution System

TRWD does not operate water treatment and distribution systems.

IV. WASTEWATER SYSTEM DATA

TRWD is a regional wholesale public water supplier and provides its customers with untreated water. It does not provide wastewater treatment services.

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APPENDIX D

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TCEQ WATER CONSERVATION IMPLEMENTATION REPORTS

Texas Commission on Environmental Quality

Water Conservation Implementation Report

Public Water Supplier

This five year report must be completed by entities that are required to submit a water conservation plan to the TCEQ in accordance with Title 30 Texas Administrative Code, Chapter 288. Please complete this report and submit it to the TCEQ. If you need assistance in completing this form, please contact the Resource Protection Team in the Water Availability Division at (512) 239-4691.

CONTACT INFORMATION

Name of Entity: Tarrant Regional Water District

Public Water Supply Identification Number (PWS ID):TCEQ Reg Entity #: RN102904463,

CCN numbers: TCEQ Cust #: CN602719957

Water Right Permit numbers: Certificates of Adjudication Nos. 08-3808 (Lake Bridgeport), 08-3809 (Eagle Mountain Lake), 08-4796 (Cedar Creek Reservoir) and 08-5035 (Richland – Chambers Reservoir) as well as Permit 5157 (Lake Benbrook)

Wastewater ID numbers: N/A

Check all that apply:

- ☐ Retail Public Water Supplier
- ☒ Wholesale Public Water Supplier

Address: 800 East Northside Drive City: Fort Worth Zip Code: 76102

Email: mark.olson@trwd.com Telephone Number: 817-335-2410

Regional Water Planning Group: C Map

Groundwater Conservation District: Click here to enter text.Map

Form Completed By: Mar Olson Title: Conservation and Creative Manager

Signature: MLO Date: 5/9/2014

Contact information for the person or department responsible for implementing the water conservation plan:

Name: Mark Olson Phone: 817-335-2491 Email: mark.olson@trwd.com
Name: Dean Minchillo Phone: 817-335-2491 Email: dean.minchillo@trwd.com

Report Completed on Date: 5/11/2014

Reporting Period (**check only one**):
☐ Fiscal Period Begin:Click here to enter a date.Period End: Click here to enter a date.
☒ Calendar Period Begin: January 2009 Period End: December 2013

Please check all of the following that apply to your entity:

☒ A surface water right holder of 1,000 acre-feet/year or more for non-irrigation uses
☐ A surface water right holder of 10,000 acre-feet/year or more for irrigation uses

Important
If your entity meets the following description, please skip page 3 and go directly to page 4.

Your entity is a Wholesale Public Water Supplier that ONLY provides wholesale water services for public consumption. For example, you only provide wholesale water to other municipalities or water districts.

Water Use Accounting

Retail Water Sold: *All retail water sold for public use and human consumption.*

Helpful Hints: There are two options available for you to provide the requested information. Both options ask the same information; however, the level of detail and break down of information differs between the two options. Please select just one option that works best for your entity and fill in the fields as completely as possible.

Fields that are gray are entered by the user. Select fields that are white and press F9 to updated fields.

For the five-year reporting period, enter the gallons of **RETAIL water sold** in each major water use category. Use **only one** of the following options.

Option 1

Water Use Category*	**Gallons Sold**
Single Family Residential	
Multi-Family Residential	
TOTAL Residential Use[1]	0
Industrial	
Commercial	
Institutional	
TOTAL Retail Water Sold[2]	0

1. [SF Res +MF Res = Residential Use]
2. [Res +Ind +Com +Ins = Retail Water Sold]

Option 2

Water Use Category *	**Gallons Sold**
Residential Select all of the sectors that your account for as "Residential". ☐Single Family ☐ Multi-Family	
Commercial Please select all of the sectors that your account for as "Commercial". ☐ Commercial ☐ Multi-Family ☐ Industrial ☐ Institutional	
Industrial Please select all of the sectors that your account for as "Industrial". ☐Industrial ☐ Commercial ☐ Institutional	
Other Please select all of the sectors that your account for as "Other". ☐Commercial ☐Multi-Family ☐ Industrial ☐ Institutional	
TOTAL Retail Water Sold[1]	0.00

1. [Res +Com +Ind + Other = Retail Water Sold]

Wholesale Water Exported: *Wholesale water sold or transferred out of the distribution system.*

For the five year reporting period, enter the gallons of **WHOLESALE water exported** to each major water use category.

Water Use Category*	**Gallons of Exported Wholesale Water**
Municipal Customers	575,449,933,341
Agricultural Customers[2]	2,376,542,132
Industrial Customers[3]	16,309,057,612
Commercial Customers	
Institutional Customers	
TOTAL Wholesale Water Exported [1, 4]	**594,135,533,085**

1. [Mun +Agr +Ind +Com +Ins = Wholesale Water Exported]

2. Agricultural Use represents water provided to golf courses for landscape irrigation, and does not represent water provided to grow agricultural crops. Used an estimated ratio of 0.40 percent to determine amount entered as "agricultural water use", which was based on water demands in 2012 and 2013.

3. The difference between total wholesale water and (municipal + agricultural use) was assumed to be industrial.

4. Total wholesale water exported and water in the municipal water category were derived from known quantities.

System Data

Fields that are gray are entered by the user. Select fields that are white and hit F9 to updated fields.

	Total Gallons During the Five-Year Reporting Period
Water Produced: Volume produced from own sources	594,135,533,085
Wholesale Water Imported : Purchased wholesale water imported from other sources into the distribution system	0
Wholesale Water Exported: Wholesale water sold or transferred out of the distribution system (Insert Total Volume calculated on Page 4)	594,135,533,085
TOTAL System Input : Total water supplied to the infrastructure	594,135,533,085 [Produced + Imported ~~– Exported~~ = System Input] All water produced as a wholesale water supplier is "exported". The volume included here is based on guidance from TWDB Annual Water Conservation Report.
Other Consumption Authorized for Use but not Sold: - back flushing water - line flushing - storage tank cleaning - golf courses - fire department use - parks - municipal government offices	
TOTAL Authorized Water Use: All water that has been authorized for use or consumption.	0.00 [Retail Water Sold + Other Consumption = Total Authorized]
Apparent Losses – Water that has been consumed but not properly measured (Includes customer meter accuracy, systematic data discrepancy, un- authorized consumption such as theft)	
Real Losses – Physical losses from the distribution system prior to reaching the customer destination (Losses less than standard meter error. Mainly due to routine pipeline maintenance and repair.)	38,500,000
Unidentified Water Losses	0.00 [System Input- Total Authorized - Apparent Losses - Real Losses = Unidentified Water Losses]
TOTAL Water Loss (only two years of data available FY 2013 and FY 2014)	38,500,000 [Apparent + Real + Unidentified = Total Water Loss]

Targets and Goals

In the table below, please provide the **specific and quantified five and ten-year targets for water savings** listed in your water conservation plan.

Fields that are gray are entered by the user. Select fields that are white and hit F9 to update fields.

Date	Target for: Total Municipal GPCD	Target for: Water Loss (expressed in GPCD)	Target for: Water Loss Percentage (expressed in Percentage)
Five-year target date: 12/31/2013	175	8.75	< 5 %
Ten-year target date: 12/31/2018	166	8.30	< 5 %

Are targets in the water conservation plan being met? Yes ☒ No ☐

If these targets are not being met, provide an explanation as to why, including any progress on these targets: Click here to enter text.

Gallons per Capita per Day (GPCD) and Water Loss

Compare your current gpcd and water loss to the above targets and goals set in your previous water conservation plan.

Total System Input in Gallons	Permanent Population, 2013	Current Total GPCD
594,135,533,085 [Produced + Imported ~~– Exported~~ = System Input]	1,817,900	179.1 [(System Input ÷ Permanent Population) /5/ 365]

Permanent Population is the total permanent population of the service area. This includes single family, multi-family, and group quarter populations. (What are group quarter populations?)

Total Municipal Use	Permanent Population	Municipal GPCD
575,449,933,341	1,817,900	173.5 [(Municipal Use ÷ Residential Population) / 5/ 365]

Residential Population is the total residential population of the service area including single & multi-family population. (You do realize that population increases over time? Population in Year 1 is less than population in Year 5)

Wholesale population served and total amount of water diverted for municipal use (in acre-feet) from utility profile included in the 2014 TRWD Water Conservation and Drought Contingency Plan (Appendix C):

Year	Total Population Served	Total Annual Diverted for Municipal Use (acre-feet)	Municipal GPCD
2009	1,796,405	331,221	164.6
2010	1,771,443	346,744	174.8
2011	1,781,735	394,034	197.4
2012	1,795,707	359,952	179.0
2013	1,817,900	334,010	163.6
Municipal GPCD without credit for reuse. Rolling 5 year average:			175.9
Municipal GPCD with credit for reuse. Rolling 5-year average:[1]			174.7

[1] In 2013, TRWD recycled 12,675 acre-feet at its Richland-Chambers Wetlands Reuse Project. Taking credit for reuse in calculating municipal gpcd reduces the amount diverted for municipal use to 321,335 acre-feet.

Total Water Loss (FY 2013 and FY 2014 data)	Total System Input in Gallons (2012 and 2013 total water use)	Permanent Population	Water Loss calculated in GPCD [1] Percent [2]	
38500000 [Apparent + Real + Unidentified = Total Water Loss]	236,399,361,033 [Water Produced + Wholesale Imported - Wholesale Exported]	1,817,900	0.03 gpcd	0.02 %

1. [Total Water Loss ÷ Permanent Population] / 2/ 365 = Water Loss GPCD]
2. [Total Water Loss ÷ Total System Input] x 100 = Water Loss Percentage]
3. Based on two years of water loss data. Used 2012 and 2013 total system input, 369,243 and 356,240 acre-feet respectively.

Water Conservation Programs and Activities

As you complete this section, please review your water conservation plan to see if you are making progress towards meeting your stated goals.

Fields that are gray are entered by the user. Select fields that are white and hit F9 to updated fields

1. Water Conservation Plan

What year did your entity adopt, or revise, their most recent water conservation plan: 2009

Does the plan incorporate Best Management Practices? Yes ☒ No ☐

2. Water Conservation Programs

For the reporting period, please select the types of activities and programs that have been actively administered, and estimate the expense and savings that incurred in implementing the conservation activities and programs for the past five years. Leave the field blank if unknown:

Program or Activity	Estimated Expenses	Estimated Gallons Saved
Conservation Analysis & Planning		
☒ Conservation Staff and Department Director	$1,440,000	
☐ Water Survey for Single-Family and Multi-Family Customers		
☒ Strategic Water Conservation Plan and additional modeling services	$330,000	
Financial		
☐ Wholesale Agency Assistance Programs		
☐ Water Conservation Pricing/ Rate Structures		
System Operations		
☒ Water Loss Audits		
☒ Leak Detection		
☒ Universal Metering and Metering Repair		
Landscaping		
☒ Landscape Irrigation Conservation and Incentives	$150,000	
☐ Athletic Fields Conservation		
☒ Golf Course Conservation		
☐ Park Conservation		
☒ Conservation Demonstration Garden	$250,000	
Education & Public Awareness		
☒ School Education	$220,000	
☒ Public Information	$5,020,000	

☒ Regional Symposium for customer cities	$125,000	
☒ Promotional Items	$62,500	
Rebate, Retrofit, and Incentive Programs		
☐ Conservation Programs for ICI Accounts		
☐ Residential Clothes Washer Incentive Program		
☐ Water Wise Landscape Design and Conversion Programs		
☐ Showerhead, Aerator, and Toilet Flapper Retrofit		
☐ Residential Toilet Replacement Programs		
☐ Rainwater Harvesting Incentive Program		
☐ ICI Incentive Programs		
Conservation Technology		
☒ Recycling and Reuse Programs (Water or Wastewater Effluent)		
☐ Rainwater Harvesting and Condensate Reuse Programs		
Regulatory and Enforcement		
☐ Prohibition on Wasting Water		
TOTAL (Approximately, includes program costs and salaries for 2.5 FE, 2009-2013)	$7,600,500	87,807,394,821

3. Reuse (Water or Wastewater Effluent)

For the reporting period, please provide the following data regarding the types of direct and indirect reuse activities that were administered for the past five years:

Reuse Activity	Estimated Volume (in gallons)
On-site irrigation	
Plant wash down	
Chlorination/de-chlorination	
Industrial	
Landscape irrigation (parks, golf courses)	
Agricultural	
Other, please describe: Richland-Chambers Indirect Reuse Project (since October – December 2013)	4,130,161,425
Estimated Volume of Recycled or Reuse	4,130,161,425

4. Water Savings

For the five-year reporting period 2009-2013, estimate the total savings that resulted from your overall water conservation activities and programs? (See table and description for how savings were derived below).

Estimated Gallons Saved (Total from Conservation Programs Table)	**Estimated Gallons Recycled or Reused** (Total from Reuse Table)	**Total Volume of Water Saved** [1]	**Dollar Value of Water Saved** [2, 3]
87,807,394,821	4,130,161,425	91,937,556,246	$70,332,231

1. [Estimated Gallons Saved + Estimated Gallons Recycled or Reused = Total Volume Saved]
2. Estimate this value by taking into account water savings, the cost of treatment or purchase of your water, and any deferred capital costs due to conservation.
3. Savings was calculated taking the average cost of wholesale water over the time period indicated above, which ranged from approximately $0.63 to $0.87 per 1,000 gallons. Average cost was $0.765 per 1,000 gallons. Savings does not take into account deferred capital costs due to conservation.

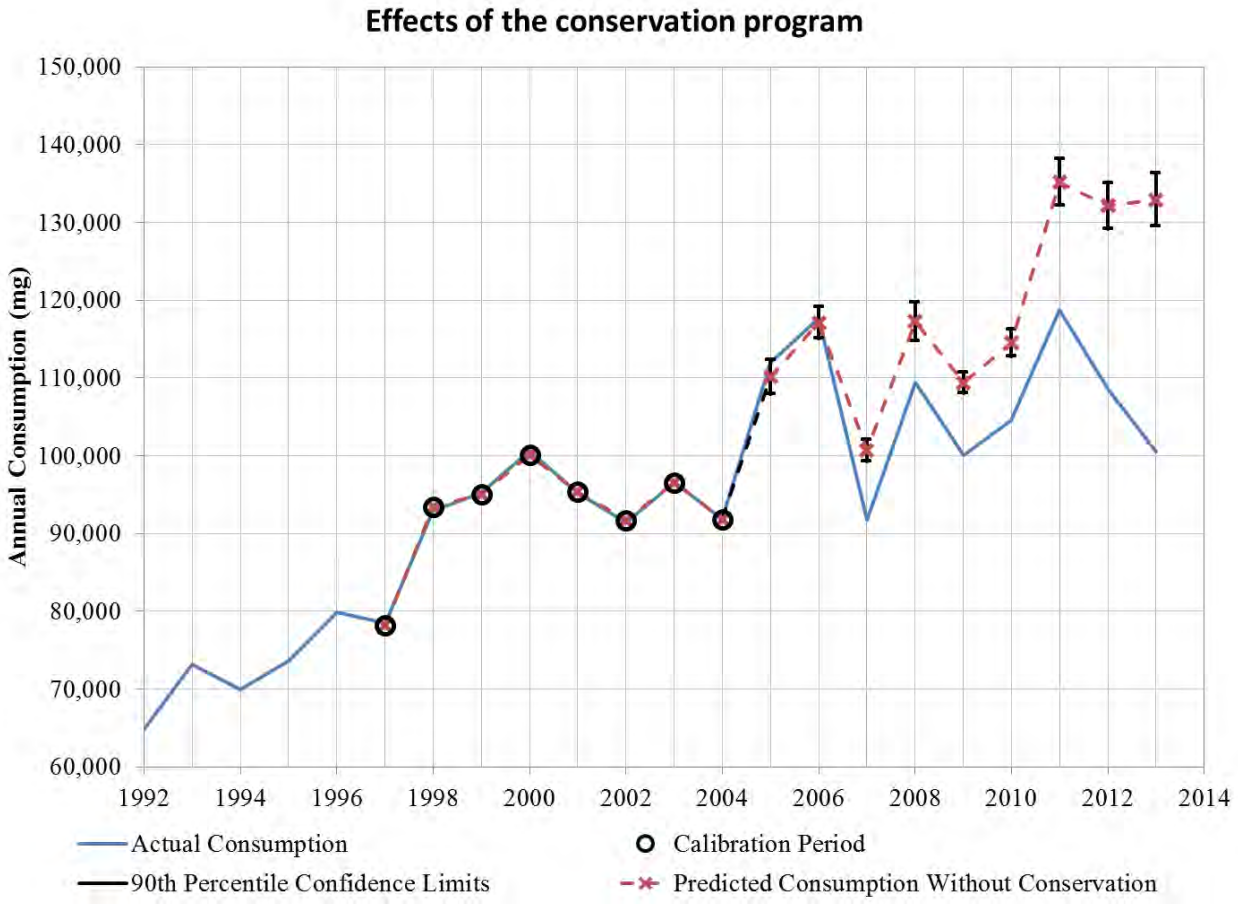
Estimated Annual Savings Due to Ongoing Water Conservation Efforts and Drought Contingency Measures, 2007-2013.

Savings based on an annual water demand model developed by Alan Plummer Associates, Inc., which was calibrated using pre-conservation program water demands, 1997-2004. Best fit parameters for TRWD demands include: average soil moisture, total June-Sept. rainfall, number of days with temperatures above 100^{o}F, and employment.

Year	Billion Gallons	Acre-Feet
2007	8.97	27,534
2008	7.95	24,395
2009	9.44	28,979
2010	9.65	29,612
2011	14.43	44,269
2012	21.86	67,070
2013	32.43	99,541
Total Savings	**104.72**	**321,400**

Note: Some savings in 2011 and 2012 can be attributed to the implementation of Stage 1 drought contingency measures, which were in effect from August 29, 2011 through May 3, 2012. The TRWD Water Conservation Strategic Plan (2013) estimates Stage 1 drought measures lowered demands by an additional 5.76 billion gallons during that timeframe. Drought restrictions in place since June 3, 2013, were also successful in reducing demands in 2013.

Savings for 2009-2013 amounted to 269,471 acre-feet or 87,807,394,821 billion gallons.



5. Conservation Pricing / Conservation Rate Structures

During the five-year reporting period, have your rates or rate structure changed? Yes ☒ No ☐

Please indicate the type of rate pricing structures that you use:

☒ Uniform rates	☐ Water Budget Based	☐ Surcharge - seasonal
☐ Flat rates	☐ Excess Use Rates	☐ Surcharge - drought
☐ Inclining/ Inverted	☐ Drought Demand rates	☐ Surcharge - usage
☐ Declining Block rates	☐ Tailored rates	
☐ Seasonal rates		

6. Public Awareness and Education Program

For the five-year reporting period, please check the appropriate boxes regarding any public awareness and educational activities that your entity has provided:

	Implemented	**Number/Unit**
Example: Brochures Distributed	☐	*10,000/year*
Example: Educational School Programs	☐	*50 students/month*
Brochures Distributed	☒	4,000/year on avg.
Messages Provided on Utility Bills	☐	N/A
Press Releases	☒	< 10
TV Public Service Announcements	☒	June – Sept each year
Radio Public Service Announcements	☒	June – Sept each year
Educational School Programs	☒	Support Major Rivers for about 5,000 middle school students in FWISD; Water Wise 5th grade curriculum reaches about 2,200 students annually
Displays, Exhibits, and Presentations	☒	15 – 25 annually
Community Events	☒	4 cleanups annually, Fort Worth Main Street Arts Festival since 2011, also support numerous events in customer cities
Social Media campaigns	☒	Ongoing since 2009
Facility Tours	☐	
Other :	☐	

7. Leak Detection

During the five-year reporting period, how many leaks were repaired in the system or at service connections: Click here to enter text.

Please check the appropriate boxes regarding the main cause of water loss in your system during the reporting period:

☐ Leaks and breaks
☐ Un-metered utility or city uses
☐ Master meter problems
☐ Customer meter problems
☐ Record and data problems
☐ Other: Click here to enter text.
☐ Other: Click here to enter text.

8. Universal Metering and Meter Repair

For the five-year reporting period, please provide the following information regarding meter repair:

	Total	Total	Total
Production Meters			
Meters larger than 1 ½"			
Meters 1 ½ or smaller			

Does your system have automated meter reading? Yes ☐ No ☒

9. Conservation Communication Effectiveness

In your opinion, how would you rank the effectiveness of your conservation activities in reaching the following types of customers for the past five years?

	Do not have activities or programs that target this type customer.	Less Than Effective	Somewhat Effective	Highly Effective
Residential Customers	☐	☐	☐	☒
Industrial Customers	☒	☐	☐	☐
Institutional Customers	☒	☐	☐	☐
Commercial Customers	☒	☐	☐	☐
Agricultural Customers	☐	☐	☒	☐

10. Drought Contingency and Emergency Water Demand Management

During the five-year reporting period, did you implement your Drought Contingency Plan?

Yes ☒ No ☐

If yes, indicate the number of days that your water use restrictions were in effect: 1) August 29, 2011 – May 4, 2012: 249 days in Stage 1 Drought; 2) June 3, 2013 – May 1, 2014: 333 days and counting in Stage 1 Drought

If yes, please check all the appropriate reasons for your drought contingency efforts going into effect.

☒ Water Supply Shortage	☐ Equipment Failure
☐ High Seasonal Demand	☐ Impaired Infrastructure
☐ Capacity Issues	☐ Other:

If you have any questions on how to fill out this form or about the Water Conservation program, please contact us at 512/239-4691.

Individuals are entitled to request and review their personal information that the agency gathers on its forms. They may also have any errors in their information corrected. To review such information, contact us at 512-239-3282.

Texas Commission on Environmental Quality

Water Conservation Implementation Report

This report must be completed by entities that are required to submit a water conservation plan to the TCEQ in accordance with Title 30 Texas Administrative Code, Chapter 288. Please complete this report and submit it to the TCEQ. If you need assistance in completing this form, please contact the Resource Protection Team in the Water Supply Division at (512) 239-4691.

Name:	Tarrant Regional Water District	
Address:	800 E. Northside Drive	
Telephone Number:	(817) 335-2491	**Fax:** (817) 877-5137
Form Completed By:	Mark Olson	**Title:** Water Conservation Coordinator
Signature:		**Date:** April 29, 2009

I. WATER USES

Indicate the type(s) of water uses (example: municipal, industrial, or agricultural).

_Municipal_____ Use

_Irrigation_____ Use

II. WATER CONSERVATION MEASURES IMPLEMENTED

Provide the water conservation measures and the dates the measures were implemented.

Public Outreach Campaign

Since spring 2007, TRWD has partnered with Dallas Water Utilities (DWU) to spread a uniform water conservation message across the Metroplex. The awareness campaign – "Save water. Nothing can replace it" – uses radio and television spots, newspaper ads, billboards, and other forms of communication to encourage people to use water responsibly. The cooperative spirit between DWU and TRWD is an excellent example of how agencies can unite to achieve a common goal. Together both agencies will spend $1.7 million for the 2009 campaign.

Brochures and Conservation Literature

TRWD developed an award-winning water conservation brochure in fall 2008. It contains water saving tips for both indoor and outdoor settings. The brochure was made available to customer cities for distribution at public events, libraries, municipal offices, garden centers, and home improvement stores. Additional printed materials will be developed as the Water District's conservation program matures and the need arises.

School Education Programs

Since 2003, TRWD has provided the "Learning to Be Water Wise" curriculum to the Fort Worth and Arlington Independent School Districts at no cost. In 2007, the city of North Richland Hills partnered with TRWD to provide the program in the Birdville ISD. The "Learning to Be Water Wise" curriculum includes student kits and activities to educate 5th grade students on the importance of water and the need for water conservation in their homes and communities. The kits contain water saving devices, which the students are encouraged to install in their own residences.

From 2004 to 2008, the Water District was a sponsor of a regional Newspapers in Education program about water. More than 1,000 area teachers signed up to receive a free supplement entitled, "Water: From Here to Eternity and Back Again." It was customized to include topics that specifically related to water issues in North Central Texas.

In 2005, TRWD began offering the "Major Rivers" curriculum to area school districts at no cost. The Arlington ISD was the first to adopt the program; the Fort Worth ISD began using it in 2007. "Major Rivers" is a curriculum designed to teach 4th grade students about Texas water resources, how water is treated and delivered to homes and schools, how to care for water resources, and how to use them wisely. A classroom package includes a teacher's guide with full color overhead transparencies, an introductory video, and full color student workbooks and home information leaflets. The Water District ordered teacher kits and replacement packages containing more than 9,000 student activity workbooks for the upcoming school year (2009-10).

Since 2005, the Water District has supported the distribution of book covers with a water conservation message to middle schools in Azle, Eagle-Mountain-Saginaw, Decatur, and Birdville Independent School Districts at no cost.

TRWD completed an interactive multi-media module in 2007 to educate students about its wetlands water reuse project. The product can be accessed online at www.trwd.com. The module blends short videos, panoramic photos and a game to teach school age children about wetland ecosystems and the environmental benefits of the water recycling project.

In 2008, the Water District created a student activitiy workbook to complement the information featured in the online wetland media module. The workbook was provided to 6th graders at All Saints Episcopal School in Fort Worth. Plans are in

the works to expand distribution to more students in the Water District's service area.

Water Efficient Landscaping

In response to drought conditions in 2005 and 2006, TRWD began encouraging its primary customers to implement 10 a.m. to 6 p.m. outdoor watering restrictions. Arlington, Fort Worth, Mansfield and most of the Water District's indirect customers in Tarrant County now have year-round ten to six outdoor watering restrictions in place.

TRWD was one of the original funding partners of the award-winning Texas SmartScape CD-ROM (originally released in May 2001). The Water District provided funding for the conversion of Texas SmartScape into an interactive Web site and for regional distribution of the CD version. Texas SmartScape is an educational tool designed to assist citizens with the design and development of landscaping using Texas native and drought tolerant plants.

In a partnership with the City of Fort Worth, TRWD helped fund the creation of a water conservation demonstration garden. The garden located at the Fort Worth Botanic Gardens was completed in May 2005. It is designed to show area residents the benefits, both environmental and aesthetic, of using native and adapted drought tolerant plants in their own residential setting. Information signs emphasizing the responsible use of our water resources are being developed.

Through a grant provided by the Texas Water Development Board, TRWD partnered with the city of Arlington in 2008 to develop another water conservation demonstration garden at the Southwest Branch Library. As a condition for grant funding, TRWD and the city coordinated workshops directed towards landscape professionals, builders, and developers on ways to design and install water efficient landscapes. Several more public workshops on waterwise landscaping were conducted spring 2009.

Internet

Beginning in 2007, TRWD began producing an online water conservation newsletter, available at its Web site (www.trwd.com). The "Supply Side" newsletter includes information about local water resources, trends in water use, and indoor and outdoor water saving suggestions.

To go along with its 2009 save water public awareness campaign, the Water District is revamping the www.savetarrantwater.com Web site. This site offers another channel to disseminate water conservation information. Ideally it will be a place to:

- Spotlight community conservation news and programs.
- Promote local events and public workshops.
- Feature stories and updates about water resources, water reuse, and conservation.

- Dig deeper into the principles of waterwise landscaping.
- Provide more in-depth and practical advice on how to save water.
- Discuss water efficient products and technology.

Community Group Presentations

TRWD has prepared and presented programs to area cities, civic organizations and other groups concerning the need for water conservation and strategies that can be implemented on an individual and corporate level. Presentations have been made to Rotary Clubs, Lions Clubs, Garden Clubs, Tarrant County Master Gardeners, Chambers of Commerce, mayors, city councils, city staff, etc.

Special Events

TRWD participates in several special events providing opportunities distribute water conservation information to the public:

The Water District sponsors a 2000-ft^2 landscape demonstration garden at Mayfest, a four-day outdoor community festival in Fort Worth. The event gives visitors an opportunity to see firsthand the beauty and water saving benefits of a Texas SmartScape. Master Gardeners of the Tarrant County Extension Office are on hand to educate the public about climate-appropriate landscaping. TRWD's participation as an exhibitor at Mayfest began in 2001.

The Water District also sponsors four lake and river cleanups annually – two in the spring and two in the fall. These special events provide excellent opportunities to emphasize the importance of protecting and conserving water resources. On average, a total of more than 2,000 volunteers join TRWD each year to clean the watersheds of Eagle Mountain Lake, Lake Bridgeport, the Trinity River, and Cedar Creek Reservoir. The first cleanup effort – the Trinity River Trash Bash – was started in 1992.

Indirect Water Reuse

TRWD is taking a lead role in water reuse by recycling return flows in the Trinity River. Return flows are a renewable resource; they are made up of water discharged by wastewater treatment plants in Fort Worth-Dallas area. A large portion of those flows originate from reservoirs managed by the Water District.

The first of TRWD's two planned indirect reuse projects began operations in spring 2009. The George Shannon Wetlands Water Recycling Facility is located adjacent to Richland-Chambers Reservoir. Over the next five years, the Water District plans to recycle enough water from the Trinity River to make up approximately two percent of its raw water supplies. That adds up to about 10 million gallons per day (MGD) eight months of the year.

Water Conservation Workshops

In 2007, the Water District held a water conservation symposium for its customer cities. The program was designed to show customers strategies that they could use

to save water, save money, and reduce demands. Speakers from across the nation were invited to share their experience and expertise. Discussions centered on key elements of successful water conservation programs. The symposium is now an annual event and jointly coordinated by the region's three major water providers – TRWD, North Texas Municipal Water District, and the city of Dallas.

In addition to the symposium, the Water District joined other North Texas water suppliers, and the Dallas and Fort Worth Chambers of Commerce to coordinate a Legislative Summit in October 2008 for state and local lawmakers. The event, which focused on water supply and conservation issues impacting North Texas, was repeated in December for water utility managers and their staff.

In summer 2008, TRWD held its first Water Conservation Coordinator Committee meeting. The meetings are held quarterly and offer representatives from many of the larger Tarrant County communities an opportunity to share water saving ideas and strategies. This is an effort by the Water District to regionalize approaches to water conservation.

Model Water Conservation and Drought Contingency Plans

Based on input from its primary customers, TRWD developed a model drought contingency plan for its direct and indirect customers in 2007. A model water conservation plan is in the process of being finalized.

III. TARGETS

A. Provide the **specific and quantified five and ten-year targets** as listed in water conservation plan for previous planning period. The numbers represent total gallons per person per day (total gpcd)

5-Year Specific/Quantified Target: 177
Date to achieve target: 2009

10-Year Specific/Quantified Target: 169
Date to achieve target: 2014

B. State if these targets in the water conservation plan are being met.

No. Using a five year rolling average, these goals have not been met. See below for an explanation.

C. List the **actual amount of water saved.**

The actual amount of water saved is difficult to quantify. However, the Water District has observed a decline in anticipated water demands of approximately 10 billion gallons annually since the implementation of 10 a.m. to 6 p.m. outdoor watering restrictions among many of its direct and indirect customers beginning in 2006.

An indirect reuse project at Richland-Chambers Reservoir, which began operations in spring 2009, will lead to additional water savings in the future. The Water District plans to recycle return flows in the Trinity River to supplement its water deliveries by approximately two percent. On average, the facility will recycle about 10 MGD during eight months of the year.

D. If the targets are not being met, provide an explanation as to why, including any progress on the targets.

As stated above, using a five year rolling average, we did not meet our target of 177 total gallons per capita per day in 2009. There are two primary reasons the goals were not achieved: (1) they were based on a single year of water use and (2) drought conditions in 2005 and 2006.

The targets listed in the Water District's 2005 Water Conservation and Drought Contingency Plan were based on a water use for a single year – 2004. The goals were essentially a snapshot of water use during a wet year, when water demands were lower than normal due excess rainfall. They were not representative of overall water use trends within the TRWD service area.

In addition, drought conditions in 2005 and 2006 led to an increase in per capita water use within the TRWD service area. In 2005, North Texas experienced the fifth driest year on record. Only 18.57 inches of rain was recorded at DFW International Airport. That's about half of what we normally receive. In 2006, more than 40 percent of the rain we received fell September through December. The rains did not provide much relief until after the peak in summertime irrigation.

However, when it comes to water use among the Water District's primary customers and their successive customers, we are seeing some positive trends and an overall decline in water use on a per capita basis. TRWD's primary customers are located in Tarrant County and include the cities of Arlington, Fort Worth, Mansfield and the Trinity River Authority (Bedford, Colleyville, Euless, Grapevine, and North Richland Hills). They are the recipients of approximately 90 to 92 percent of all TRWD water deliveries. A list of all direct and indirect customers is included in Section 3 of this Water Conservation and Drought Contingency Plan.

The declines in per capita demands can be observed when comparing total water use in years with similar climatic conditions. The discussion that follows is based on information in Table 4.1.

Looking at water use comparisons between two wet years (2004 and 2007), TRWD water deliveries remained essentially unchanged at 282,700 and 284,343 acre-feet, respectively. However, the estimated population of our primary customers increased by approximately 113,000 or 7.6 percent. The result was more people using about the same amount of water, which can be observed by the drop in demands – from 170 to 158.9 total gpcd in 2004 and 2007, respectively. The average reduction of 11.1 gallons per person per day represents a decline in consumer demands of about 6.5 percent.

The decline is not so dramatic when comparing two moderately dry years (2003 and 2008). Per capita water use decreased slightly between those years from 186.0 to 184.6 total gpcd in 2003 and 2008, respectively; population increased by approximately 12.8 percent, while the amount of water supplied to our primary customers increased 12.0 percent. It doesn't look like much of a change on the surface, but the real story lies in the difference between the amounts of precipitation received during the summer (when water use is at its peak). In 2003, North Texas received more than twice the rainfall (June through September) than it did in 2008.

A better comparison might be to look at water use between 2006 and 2008. Precipitation amounts in each of those years were very similar, especially during the summer months with an observed difference of only 0.07 inches. Drought conditions were also prevalent in each year. Despite the similar climatic conditions and a 4.3 percent increase in population, water consumption was much lower in 2008. Total gpcd declined from 206.8 to 184.6 in 2006 and 2008, respectively – a decrease of nearly 11 percent.

It's hard to pinpoint the exact reasons for the reductions we are observing in water consumption on a per capita basis. However, we are confident that some of the lower demands are due to the water conservation strategies being put into effect. We feel like the 10 to 6 outdoor watering restrictions are making a difference. Regionalizing our conservation efforts is also important. That's why the Water District is striving to build partnerships with its customers and other water providers throughout North Texas. Teaming up with the city of Dallas to share costs and encourage responsible water use through the "Save Water – Nothing can replace it" outreach campaign is a great example.

Based on our observations, conservation is gaining traction in North Texas. Water use on a per capita basis is decreasing and the Water District is taking steps to increase the likelihood that the trend will continue.

If you have any questions on how to fill out this form or about the Water Conservation program, please contact us at 512/239-4691.

Individuals are entitled to request and review their personal information that the agency gathers on its forms. They may also have any errors in their information corrected. To review such information, contact us at 512-239-3282.

APPENDIX E

ANNUAL WATER CONSERVATION REPORTS SUBMITTED TO TEXAS WATER DEVELOPMENT BOARD (TWDB)

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APPENDIX E
Annual Water Conservation Reports Submitted to TWDB
TRWD Water Use Information (2013)

Water Conservation Annual Report – Wholesale Water Suppliers
TWDB Form No.1969
Revised on 1/10/13

Water Conservation Plan Annual Report
Wholesale Water Supplier

CONTACT INFORMATION

Name of Entity: Tarrant Regional Water District

Public Water Supply Identification Number (PWS ID): _____

CCN Number: TCEQ Reg Entity #: RN102904463, TCEQ Cust #: CN602719957

Water Rights ID Number: Certificates of Adjudication Nos. 08-3808 (Lake Bridgeport),

Wastewater ID Number: _____

Check all that apply:

- ☐ Retail Water Supplier
- ☑ Wholesale Water Supplier
- ☐ Wastewater Treatment Utility

Address: 800 E. Northside Drive City: Fort Worth Zip Code: 76102

Email: mark.olson@trwd.com Telephone Number: 817-335-2491

Regional Water Planning Group: C Map

Groundwater Conservation District: _____ Map

Form Completed By: Mark Olson & Laura Blaylock Title: Conservation and Cre

Date: 04-24-2014

Reporting Period (**check only one**):

- ○ Fiscal Period Begin(mm/yyyy) _____ Period End(mm/yyyy) _____
- ◉ Calendar Period Begin(mm/yyyy) 01/2013 Period End(mm/yyyy) 12/2013

Check all that apply:

- ☐ Received financial assistance of $500,000 or more from TWDB
- ☐ Have 3,300 or more retail connections
- ☑ Have a surface water right with TCEQ

Page **1** of **5**

Water Conservation Annual Report ~ Wholesale Water Suppliers
TWDB Form No.1969
Revised on 1/10/13

SYSTEM DATA

1. For this reporting period, provide the **total volume of wholesale water exported** (transferred or sold): 116081160240 gallons

2. For this reporting period, does your billing/accounting system have the capability to classify customers into the Wholesale Customer Categories?
   (●) Yes ( ) No

3. For this reporting period, select the category(s) used to calculate wholesale customer water usage:
   - [x] Municipal
   - [x] Industrial
   - [ ] Commercial
   - [x] Institutional
   - [ ] Agricultural

Wholesale Customer Categories*
- Municipal
- Industrial
- Commercial
- Institutional
- Agricultural

**Recommended Customer Categories for classifying customer water use. For definitions, refer to Guidance and Methodology on Water Conservation and Water Use.*

4. For this reporting year, enter the gallons of **WHOLESALE water exported** (transferred or sold). Enter zero if a Customer Category does not apply.

Wholesale Customer Category	Gallons Exported (transferred or sold)	Number of Customers
Municipal	108837492510	28
Industrial	6801162072	5
Commercial	0	
Institutional	0	
Agricultural	442,505,658	15
~~Total~~	116081160240	48

Water Conservation Annual Report ~ Wholesale Water Suppliers
TWDB Form No.1969
Revised on 1/10/13

Water Use Accounting

	Total Gallons During the Reporting Period
Water Produced: Water from permitted sources such as rivers, lakes, streams, and wells.	116081160240
Wholesale Water Imported: Purchased wholesale water transferred into the system.	0
System Input: Total water supplied to system and available for use.	116081160240 Produced + Imported = System Input
Wholesale Water Exported: Wholesale water sold or transferred out of the system.	116081160240
Gallons Per Day:	318,030,576 Wholesale Water Exported ÷ 365 = Gallons Per Day
Population: Estimated total population for municipal customers.	1,817,900
	164 Municipal Exported ÷ Municipal Population ÷ 365 = Municipal Gallons Per Capita Per Day

Provide the **specific and quantified five and ten-year targets** as listed in your most current Water Conservation Plan.

	Date to Achieve Target	Specified and Quantified Targets
Five-year target	2013	Rolling 5-year avg. = 175
Ten-year target	2018	Rolling 5-year avg. = 166

Water Conservation Annual Report ~ Wholesale Water Suppliers
TWDB Form No.1969
Revised on 1/10/13

Water Conservation Programs and Activities

1. Water Conservation Plan

What year did your entity adopt or revise their most recent Water Conservation Plan? 2009

Does The Plan incorporate Best Management Practices? (●) Yes ( ) No

2. Water Conservation Programs

Has your entity implemented any type of water conservation activity or program?
(●) Yes ( ) No

If yes, select the type(s) of Best Management Practices or water conservation strategies implemented during this reporting period.

Wholesale Supplier Activities and Practices	
☐	Agricultural Conservation Programs
☑	Conservation Analysis & Planning
☐	Conservation Rate Structures
☐	Conservation Technology
☑	Education & Public Awareness
☐	Industrial Conservation Programs
☑	Leak Detection/ Water Loss Program
☐	Rebate, Retrofit, and Incentive Programs
☐	Regulatory & Enforcement
☑	System Operations
☑	Water Efficient Landscape Programs
☑	Water Use Audits

Other activities, list or describe.

Notes:
1) Launched joint public outreach media campaign with City of Dallas beginning in 2009.

3. Recycle/Reuse (Water or Wastewater Effluent)

For this reporting period, provide direct and indirect reuse activities.

Reuse Activity	Estimated Volume (in gallons)
On-site irrigation	
Plant wash down	
Chlorination/de-chlorination	
Industrial	
Landscape irrigation (parks, golf courses)	
Agricultural	
Other, please describe: Richland-Chambers Wetlands Indirect	4,130,161,425
Estimated Volume of Reuse	4,130,161,425

Water Conservation Annual Report – Wholesale Water Suppliers
TWDB Form No.1969
Revised on 1/10/13

4. Water Savings

For this reporting period, estimate the savings that resulted from water conservation activities and programs.

Estimated Gallons Saved/Conserved	Estimated Gallons Recycled/Reused	Total Volume of Water Saved[1]	Dollar Value of Water Saved[2]
32435000000	4,130,161,425	36565161425	$ 31,994,151

1. Estimated Gallons Saved + Estimated Gallons Recycled/Reused = Total Volume Saved
2. Estimate this value by taking into account water savings, the cost of treatment or purchase of water, and deferred capital costs due to conservation.

5. Program Effectiveness

In your opinion, how would you rank the overall effectiveness of your conservation programs and activities?

Less Than Effective	Somewhat Effective	Highly Effective	Does Not Apply
○	○	◉	○

6. What might your entity do to improve the effectiveness of your water conservation program?

We've been under Stage 1 drought restrictions since June 3, 2013. Our average daily water use, due in large part to the restrictions, was nearly 30 mgd less than it was last year. The drought conditions combined with an increased awareness of the status of our water supplies is helping to lower demands. In addition, we are confident that our water conservation awareness and education program is making a difference. Add to that, the programs implemented by our customers, such as tiered water rates, water loss and leak

7. Select the areas for which you would like to receive technical assistance:

- ☐ Agricultural Best Management Practices
- ☐ Wholesale Best Management Practices
- ☐ Industrial Best Management Practices
- ☐ Drought Contingency Plans
- ☐ Landscape Efficient Systems
- ☐ Leak Detection and Equipment
- ☐ Educational Resources
- ☐ Water Conservation Plans
- ☐ Water IQ: Know Your Water
- ☐ Water Loss Audits
- ☐ Rainwater Harvesting Systems
- ☐ Recycling and Reuse

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TRWD Water Use Information (2012)

Water Conservation Annual Report – Wholesale Water Suppliers
TWDB Form No.1969
Revised on 1/10/13

Water Conservation Plan Annual Report
Wholesale Water Supplier

CONTACT INFORMATION

Name of Entity: Tarrant Regional Water District

Public Water Supply Identification Number (PWS ID): _____

CCN Number: TCEQ Reg Entity #: RN102904463, TCEQ Cust #: CN602719957

Water Rights ID Number: Certificates of Adjudication Nos. 08-3808 (Lake Bridgeport),

Wastewater ID Number: _____

Check all that apply:

- ☐ Retail Water Supplier
- ☑ Wholesale Water Supplier
- ☐ Wastewater Treatment Utility

Address: 800 E. Northside Drive City: Fort Worth Zip Code: TX

Email: mark.olson@trwd.com Telephone Number: 817-335-2491

Regional Water Planning Group: C Map

Groundwater Conservation District: _____ Map

Form Completed By: Mark Olson & Laura Blaylock Title: Conservation Manage

Date: 04-25-2013

Reporting Period (**check only one**):

- ○ Fiscal Period Begin(mm/yyyy) _____ Period End(mm/yyyy) _____
- ◉ Calendar Period Begin(mm/yyyy) 01/2012 Period End(mm/yyyy) 12/2012

Check all that apply:

- ☐ Received financial assistance of $500,000 or more from TWDB
- ☐ Have 3,300 or more retail connections
- ☑ Have a surface water right with TCEQ

Page **1** of **5**

Water Conservation Annual Report ~ Wholesale Water Suppliers
TWDB Form No.1969
Revised on 1/10/13

SYSTEM DATA

1. For this reporting period, provide the **total volume of wholesale water exported** (transferred or sold): 120,504,011,170 gallons

2. For this reporting period, does your billing/accounting system have the capability to classify customers into the Wholesale Customer Categories?
   (●) Yes ( ) No

3. For this reporting period, select the category(s) used to calculate wholesale customer water usage:
   - [x] Municipal
   - [x] Industrial
   - [ ] Commercial
   - [x] Institutional
   - [ ] Agricultural

Wholesale Customer Categories*
- Municipal
- Industrial
- Commercial
- Institutional
- Agricultural

**Recommended Customer Categories for classifying customer water use. For definitions, refer to Guidance and Methodology on Water Conservation and Water Use.*

4. For this reporting year, enter the gallons of **WHOLESALE water exported** (transferred or sold). Enter zero if a Customer Category does not apply.

Wholesale Customer Category	Gallons Exported (transferred or sold)	Number of Customers
Municipal	115,461,973,364	27
Industrial	4,476,300,880	7
Commercial	0	
Institutional	565,736,926	15
Agricultural	0	
~~Total~~	120,504,011,170	49

Water Conservation Annual Report – Wholesale Water Suppliers
TWDB Form No.1969
Revised on 1/10/13

Water Use Accounting

	Total Gallons During the Reporting Period
Water Produced: Water from permitted sources such as rivers, lakes, streams, and wells.	120,504,011,170
Wholesale Water Imported: Purchased wholesale water transferred into the system.	0
System Input: Total water supplied to system and available for use.	120,504,011,170 Produced + Imported = System Input
Wholesale Water Exported: Wholesale water sold or transferred out of the system.	120,504,011,170
Gallons Per Day:	330,147,976 Wholesale Water Exported ÷ 365 = Gallons Per Day
Population: Estimated total population for municipal customers.	1,795,613
	176 Municipal Exported ÷ Municipal Population ÷ 365 = Municipal Gallons Per Capita Per Day

Provide the **specific and quantified five and ten-year targets** as listed in your most current Water Conservation Plan.

	Date to Achieve Target	Specified and Quantified Targets
Five-year target	2013	Rolling 5-yr avg. = 175
Ten-year target	2018	Rolling 5-yr avg. = 166

Water Conservation Annual Report ~ Wholesale Water Suppliers
TWDB Form No.1969
Revised on 1/10/13

Water Conservation Programs and Activities

1. Water Conservation Plan

What year did your entity adopt or revise their most recent Water Conservation Plan? 2009

Does The Plan incorporate Best Management Practices? (●) Yes ( ) No

2. Water Conservation Programs

Has your entity implemented any type of water conservation activity or program?
(●) Yes ( ) No

If yes, select the type(s) of Best Management Practices or water conservation strategies implemented during this reporting period.

Wholesale Supplier Activities and Practices	
☐	Agricultural Conservation Programs
☑	Conservation Analysis & Planning
☐	Conservation Rate Structures
☐	Conservation Technology
☑	Education & Public Awareness
☐	Industrial Conservation Programs
☑	Leak Detection/ Water Loss Program
☐	Rebate, Retrofit, and Incentive Programs
☐	Regulatory & Enforcement
☐	System Operations
☑	Water Efficient Landscape Programs
☑	Water Use Audits

Other activities, list or describe.

Notes:
1) Launched joint public outreach media campaign with City of Dallas beginning in 2009.

3. Recycle/Reuse (Water or Wastewater Effluent)

For this reporting period, provide direct and indirect reuse activities.

Reuse Activity	Estimated Volume (in gallons)
On-site irrigation	
Plant wash down	
Chlorination/de-chlorination	
Industrial	
Landscape irrigation (parks, golf courses)	
Agricultural	
Other, please describe:	
Estimated Volume of Reuse	0

Water Conservation Annual Report – Wholesale Water Suppliers
TWDB Form No.1969
Revised on 1/10/13

4. Water Savings

For this reporting period, estimate the savings that resulted from water conservation activities and programs.

Estimated Gallons Saved/Conserved	Estimated Gallons Recycled/Reused	Total Volume of Water Saved[1]	Dollar Value of Water Saved[2]
21,855,199,468	0	21,855,199,468	$ 17,800,000

1. Estimated Gallons Saved + Estimated Gallons Recycled/Reused = Total Volume Saved
2. Estimate this value by taking into account water savings, the cost of treatment or purchase of water, and deferred capital costs due to conservation.

5. Program Effectiveness

In your opinion, how would you rank the overall effectiveness of your conservation programs and activities?

Less Than Effective	Somewhat Effective	Highly Effective	Does Not Apply
○	○	◉	○

6. What might your entity do to improve the effectiveness of your water conservation program?

We are confident that our water conservation awareness and education program is effectively reaching customers and improving the efficiency of their water use. The programs implemented by our customers, such as tiered water rate structures and permanent daytime watering restrictions are also lowering overall demands. We will evaluate the options presented in our recently published strategic water conservation plan to increase water savings in the future. One option we are pursuing is the adoption of a

7. Select the areas for which you would like to receive technical assistance:

- ☐ Agricultural Best Management Practices
- ☐ Wholesale Best Management Practices
- ☐ Industrial Best Management Practices
- ☐ Drought Contingency Plans
- ☐ Landscape Efficient Systems
- ☐ Leak Detection and Equipment
- ☐ Educational Resources
- ☐ Water Conservation Plans
- ☐ Water IQ: Know Your Water
- ☐ Water Loss Audits
- ☐ Rainwater Harvesting Systems
- ☐ Recycling and Reuse

SUBMIT

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APPENDIX F

TRWD CUSTOMER WATER CONSERVATION REPORT

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APPENDIX F
Customer Water Conservation Report
Due May 1 of Every Year

Name of Entity: _____

Address & Zip: _____

Telephone Number: _____ **Fax:** _____

Form Completed By: _____

Title: _____

Signature: _____ **Date:** _____

Name and Phone Number of Person/Department responsible for implementing a water conservation program:

_____

NOTE: A downloadable and more user friendly version of this report can be found on the TCEQ web site at http://www.tceq.state.tx.us/permitting/water_rights/conserve.html/#forms.

UTILITY PROFILE

I. POPULATION CUSTOMER DATA

A. Population and Service Area Data

1. Attach a copy of your service area map.
2. Service area size (square miles): _____
3. Current population of service area: _____
4. Current population served by utility:
   a: water _____
   b: wastewater _____

5. Population served by water utility service area for the previous five years:

Year	Population
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

6. Projected population for in the following decades:

Year	Population
2020	_____
2030	_____
2040	_____
2050	_____
2060	_____

7. List specific source(s)/method(s) for the calculation of current and projected population:

B. Customers Data

Senate Bill 181 requires that uniform consistent methodologies for calculating water use and conservation be developed and available to retail water providers and certain other water use sectors as a guide for preparation of water use reports, water conservation plans, and reports on water conservation efforts. A water system must provide the most detailed level of customer and water use data available to it, however, any new billing system purchased must be capable of reporting data for each of the sectors listed below. http://www.tceq.texas.gov/assets/public/permitting/watersupply/water_rights/sb181_guidance.pdf

1. Current number of active connections by user type. Check whether multi-family service is counted as Residential ___ or Commercial ____ .

Treated water users	Metered	Not-metered	Totals
Residential:			
Single Family			
Multi-Family			
Commercial			
Industrial/mining			
Institutional			
Agriculture			
Other/Wholesale			

2. List the new number of new connections per year for most recent three years:

Year			
Treated water users	**Metered**	**Not-metered**	**Totals**
Residential:			
Single Family			
Multi-Family			
Commercial			
Industrial/mining			
Institutional			
Agriculture			
Other/Wholesale			

3. List annual water use for the five highest volume customers.

	Customer	Use (1,000 gallons / year)	Treated / Raw Water
(1)			
(2)			
(3)			
(4)			
(5)			

II. WATER USE DATA FOR SERVICE AREA

A. Water Accounting Data

1. Amount of water use for previous five years (in 1,000 gal.):

   Please indicate: Diverted Water _____

   Treated Water _____

Total Diverted and Treated Water Deliveries and Sales by Month					
Month	**Year**				
January					
February					
March					
April					
May					
June					
July					
August					
September					
October					
November					
December					
Total					

Describe how the above figures were determined (e.g., from a master meter located at the point of a diversion from the source or located at a point where raw water enters the treatment plant, or from water sales).

2. Amount of water (in 1,000 gallons) delivered (sold) as recorded by the following account types for the past five years.

Account Types	**Year**				
Residential					
Single Family					
Multi-Family					
Commercial					
Industrial/Mining					
Institutional					
Agricultural					
Other/Wholesale					

3. List previous records for water loss (the difference between water diverted or treated and water delivered or sold). The goal for percent of unaccounted for water is 12%.

Year	**Amount (gal.)**	**% of Total Water Diverted or Treated**
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

4. List previous five years records for water reuse. Reuse is the authorized use for one or more beneficial purposes of use of water that remains unconsumed after the water is used for the original purpose of use and before that water is either disposed of or discharged or otherwise allowed to flow into a watercourse, lake or other body of state-owned water.

Year	**Amount (gal.)**	**% of Total Water Diverted or Treated**
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

5. Municipal per capita water use (in gallons per day) for previous five years. Municipal per capita water use is the sum total of water diverted into a water supply system for residential, commercial, and public and institutional uses divided by total population served. GPCD includes water losses.

Year	**Population**	**Total Water Diverted (or Treated)(1,000 gal.)**	**Municipal Per Capita Use (GPCD)**
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

Source of Population data: _____

_____

B. Projected Water Demands

If applicable, attach or cite projected water supply demands for next ten years using information such as population trends, historical water use, and economic growth in the service area and any additional water supply requirement for such growth.

APPENDIX G

TRWD STRATEGIC WATER CONSERVATION PLAN EXECUTIVE SUMMARY

JANUARY 2013

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APPENDIX G
TRWD Strategic Water Conservation Plan Executive Summary (2013)

TRWD Strategic Water Conservation Plan

ES. Executive Summary

Over the next fifty years, total TRWD water demands are projected to double (Ref. 1). Proposed water management strategies for TRWD include water conservation, water reuse projects at Richland-Chambers Reservoir and Cedar Creek Reservoir, participating with other water suppliers to develop Marvin Nichols Reservoir, and participating with other water suppliers to obtain water from Toledo Bend Reservoir and from Oklahoma. The projected capital cost for these projects is $4.73 billion (Ref. 1).

To obtain water from Marvin Nichols Reservoir (to be located in the Sulphur River Basin) by 2030 and Toledo Bend Reservoir (located in the Sabine River Basin) by 2050, the TRWD and other project participants will have to apply for and obtain authorization to transfer water to the Trinity River Basin. Currently, interbasin transfer regulations require applicants to have "developed and implemented a water conservation plan that will result in the highest practicable levels of water conservation and efficiency achievable within the jurisdiction of the applicant" (Ref. 2).

From 2007 through 2011, ongoing water conservation efforts have helped TRWD to save approximately 42.4 billion gallons (130,250 acre-feet) of water, for an average savings of 23.2 million gallons per day (mgd). At the current per capita water demand, these water savings have stretched the existing water supply enough to meet the needs of an additional 132,200 people. This Strategic Water Conservation Plan (Strategic Plan) provides a road map to additional water savings and is an important step toward achieving the "highest practicable levels of water conservation and efficiency." Implementation of this Strategic Plan will extend the life of existing TRWD water supplies and reduce operating costs. Other potential benefits include delaying the need for new water supplies, deferring the associated capital costs, and minimizing associated environmental impacts. This document defines water conservation goals for the five-year planning period from 2013 through 2017 and recommends water conservation measures, budgets, and staffing levels to achieve these goals.[1]

ES.1. Strategic Plan Development Process (Section 1.1)

This document was developed through review of numerous water conservation programs, measures, data, and literature and through input from TRWD staff, TRWD wholesale customer cities, and water conservation staff from other cities.

Water use data from TRWD and its four primary customers (Fort Worth, Arlington, Mansfield, the Trinity River Authority Tarrant County Water Supply Project and their successive customers) were examined to identify strategic areas to target for additional water conservation opportunities. Numerous water conservation measures were evaluated using screening criteria, a benefit-cost analysis, and other means to determine their suitability for implementation during the five-year planning period. New water conservation goals were established, and recommended

[1] In the title of each section of the Executive Summary, the corresponding section in the main report is identified in parentheses.

measures were constructed into a framework plan and presented to TRWD and its customer cities for comment. Feedback was analyzed and used to develop the Strategic Plan.

ES.2. TRWD Primary Customers Water Use Profile (Chapter 4)

To make recommendations that are technically sound and economically feasible, water conservation planners must understand the customer makeup and water use patterns of the service area. Historical water use by the four primary customers and their successive customers was obtained from TRWD and from utility profiles (Figure ES-1). The customer utility profiles contain additional water use information that can be used to further break down historical water use by residential, commercial, industrial, other, and nonrevenue water uses. For the period 2004 to 2008, the customer utility profiles account for 81.5 to 86.9 percent of the water that TRWD delivered to the four primary customers. Because this represents the large majority of water used by the four primary customers, conclusions based on the reported data will be generalized to all TRWD water used by the four primary customers.

Water Sales by Sector (Section 4.2)

The utility profiles report water sales by residential, commercial, industrial, wholesale, and other sectors. For 2004 to 2008, Figure ES-2 shows the weighted average distribution of water sales by customer type for the four primary customers. Residential sales comprise 59.6 to 66.8 percent of retail water sales, commercial sales comprise 24.1 to 31.6 percent, and industrial sales comprise 4.5 to 7.2 percent.

Per-Capita Water Use (Section 4.3)

Total annual water use by the four primary customers is normalized by their populations in Figure ES-3. Some of the variability in annual water use can be attributed to differences in weather from year to year. To better filter out the impact of weather on the annual data, five-year running averages were calculated (Figure ES-3). The five-year running average has declined from 195.8 gpcd in 2002 to 175.8 gpcd in 2011, a decrease of about 1.1 percent per year.

Reported residential water sales are normalized by population in Figure ES-4. Given the available water use data, it is not feasible to separate indoor and outdoor residential water use. The range of residential water sales during the period 2004 to 2008 was about 82 gpcd to 109 gpcd.

Nonrevenue Water and Water Loss (Section 4.4)

Based on the reported data, the calculated average nonrevenue water for the four primary TRWD customers ranged from 12.7 percent to 17.2 percent of total water diversions, depending on the year. Data quality control issues suggest that the actual nonrevenue water percentages are somewhat greater.

Figure ES-1: Water Use by TRWD's Primary Customers and Their Successive Customers

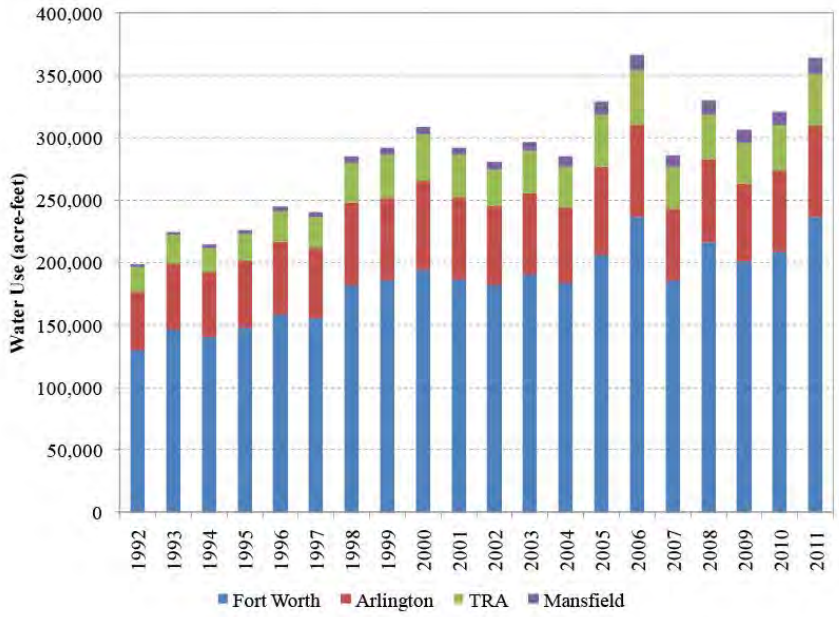


Figure ES-2: Weighted Average Retail Water Sales Distribution by Customer Type for the Four Primary Customers

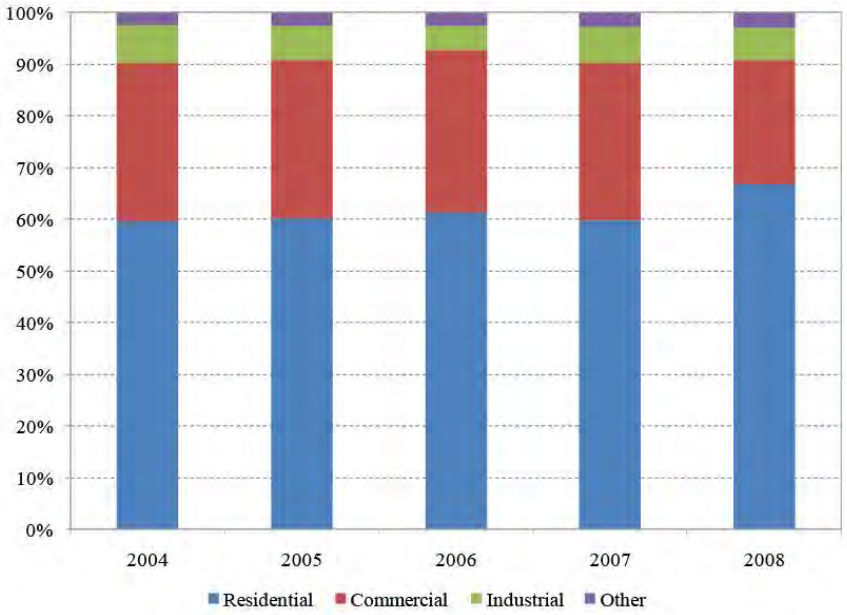


Figure ES-3: Total Water Use Normalized by Population for the Four Primary Customers

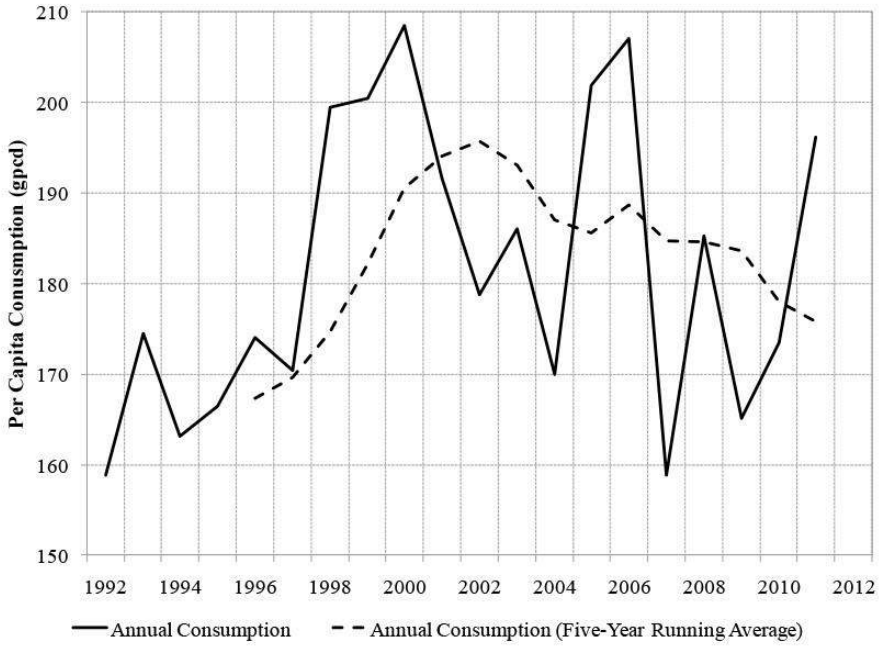
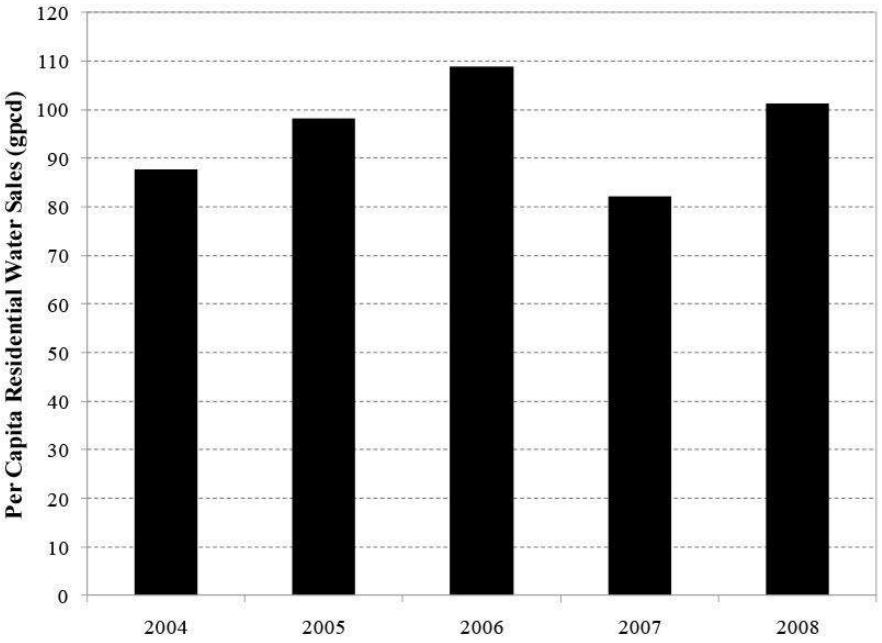


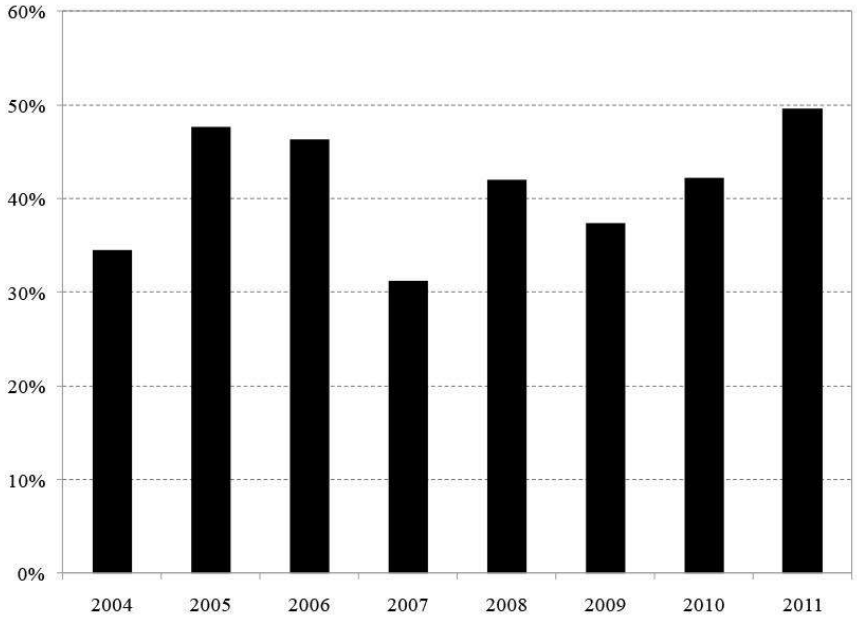
Figure ES-4: Residential Water Sales Normalized by Population for Reporting Customers



Seasonal Water Use (Section 4.5)

On an annual basis, the four primary customers use 31 percent to 50 percent of their water for seasonal uses (Figure ES-5), depending on climatic conditions. Seasonal water uses include lawn irrigation, cooling water, and other water uses that increase in the summer. The customers use more water for seasonal uses during hot, dry conditions.

Figure ES-5: Seasonal Water Use as a Percentage of Total Water Use for the Four Primary Customers



NOTE: Seasonal water uses include lawn irrigation, cooling water, and other water uses that increase in the summer.

ES.3. Identification and Screening of Potential Water Conservation Measures (Chapter 9)

Potential water conservation measures were compiled from various sources, including recommendations by task forces and planning groups, literature sources, and successful regional water conservation programs implemented by other utilities. Potential water conservation measures are presented in Appendix E.

Based on the TRWD water use profile, screening criteria were developed to help determine which new or enhanced water conservation measures would be most effective for the TRWD service area during the next five years. Using these screening criteria, the measures in Table ES-1 were selected for detailed evaluation of probable water savings, benefits, and costs. These measures address a broad range of customer types and water use types.

Table ES-1: Water Conservation Measures Selected for Detailed Evaluation

	Measure	Customer Type				Use Type		Measure Type			
		SF	MF	ICI	Municipal/ Utility	Indoor/ Base	Outdoor/ Seasonal	Education/ Outreach	Rebate/ Incentive	Regulation	Other
1	High-efficiency toilet (HET) distribution/incentives	✓	✓	✓		✓			✓		
2	Toilets, natural replacement with HETs	✓	✓	✓		✓				✓	
3	High-efficiency clothes washer (HECW) incentives	✓	✓	✓		✓			✓		
4	Residential clothes washers, natural replacement with HECWs	✓	✓			✓				✓	
5	Pre-rinse spray valve retrofits			✓		✓			✓		
6	ICI customer water audits			✓		✓		✓			
7	Site-specific ICI incentives			✓		✓	✓		✓		
8	Cooling tower incentives			✓			✓		✓		
9	ICI recognition program			✓		✓	✓	✓			
10	Irrigation system evaluations	✓	✓	✓			✓	✓			
11	Irrigation system incentives	✓	✓	✓			✓		✓		
12	Rainwater harvesting incentives	✓	✓	✓			✓		✓		
13	Irrigation limits: maximum 2 times per week	✓	✓	✓			✓	✓		✓	
14	Public education (ET irrigation recommendations)	✓	✓	✓			✓	✓			
15	Golf course conservation and reuse			✓	✓		✓	✓			
16	Model landscape ordinance	✓	✓	✓	✓		✓	✓		✓	
17	Water loss reduction			✓	✓	✓		✓			
18	Water use reduction due to increases in real water price	✓	✓	✓		✓	✓				✓
19	Wholesale customer assistance	✓	✓	✓		✓	✓		✓		
20	Model conservation ordinance	✓	✓	✓	✓	✓	✓	✓		✓	
	NUMBER OF MEASURES	13	13	18	4	12	13	9	8	5	1

SF = Single-family residential
MF = Multi-family residential
ICI = Industrial, commercial, and institutional

ES.4. Detailed Evaluation of Selected Water Conservation Measures (Chapter 10)

The goals of the Strategic Plan are to:

- Develop and implement water conservation programs aimed at:
  - Decreasing per capita water use (gpcd)
  - Reducing seasonal peak demands
  - Reducing water loss and waste
- Target an average one percent per year reduction in the five-year average per capita consumption for the five-year planning period (Figure 10-1).[2] This results in an 8.6 gpcd reduction over five years. This target is exclusive of any credit for indirect reuse diversion volumes (see Section 8.2). This goal is consistent with the recommendations of the statewide Water Conservation Implementation Task Force (Ref. 7) and with TRWD's published 2018 water use goal of 166 gpcd (Table 6-1 and Ref. 3).
- Continue a heightened public awareness of water conservation in the TRWD service area and the North Texas region.
- Continue and enhance conservation practices that will maintain quality of life and allow economic growth and development.
- Continue to include broad-based public and private stakeholder groups in new program development and implementation processes.
- Continue to lead by example by upgrading TRWD facilities with water-efficient fixtures, landscapes, and irrigation systems wherever possible.
- Assist in facilitating regional conservation efforts among TRWD customer cities.
- Establish the foundation for continuation of water savings targets for the following five-year period and succeeding five-year intervals.

The measures listed in Table ES-1 were evaluated based on the following:

- TRWD's water conservation goals for the next five years
- Projected water savings
- Probable benefits
- Probable costs
- Feedback from wholesale customer cities.

[2] Assumes that existing water conservation measures will maintain the existing five-year average per capita water consumption until 2013, when the first recommended water conservation measures from this Strategic Plan will be implemented.

ES.5. Recommended Implementation Plan, 2013 through 2017 (Chapter 11)

Considering how effective TRWD's water conservation program has been over the last several years (Figure ES-3), all of the water conservation measures presently employed by TRWD are recommended for continuation through the planning period. In addition, it will be important to use the multimedia public outreach campaign to educate the public about new measures as they are implemented and to encourage participation.

The recommended implementation schedule for the next five years (Table ES-2 and Figure ES-6) is based on the following prioritization criteria for new water conservation measures:

- Implement the more cost-effective measures early. However, if necessary, delay implementation while working to increase public acceptance.
- Implement measures with higher water savings early.
- Limit the number of programs to be planned/implemented each year based on the capacity of the existing water conservation staff.
- Align strategies that have similarities/synergies.

The following recommendations are given in support of the implementation schedule (Table ES-2):

- As soon as possible, TRWD should develop a model conservation ordinance and encourage customers to adopt and enforce the ordinance.
- TRWD is already working to implement the public education (ET irrigation recommendations) measure. The golf course conservation measure will build on this measure by encouraging golf courses to use the ET irrigation recommendations. Both of these are relatively low-cost measures, and they are also recommended for implementation in 2013.
- TRWD should develop a model ordinance restricting irrigation to a maximum of two times per week and encourage customers to adopt and enforce the ordinance. This measure would make permanent the irrigation restriction that TRWD activated from August 29, 2011 through May 3, 2012 as part of Stage 1 of its Drought Contingency Plan. Although this measure is projected to have substantial water savings, implementation should be delayed until 2014 to allow TRWD to work with its wholesale customers to communicate the benefits of a twice-weekly watering limitation to council and board members, other decision-makers, and the public.
- Although the high-efficiency toilet distribution/incentives measure is the most cost-effective active measure in the long-term, it will require substantial budget increases. Since there is not sufficient time remaining to increase the budget for 2013, it is recommended that the high-efficiency toilet distribution/incentives measure be implemented in 2014.
- TRWD should create an "ICI Device Incentives Menu" to promote use of water-efficient fixtures and equipment by a large number of ICI customers. This menu would begin with implementation of high-efficiency toilet distribution/incentives in 2014 and would

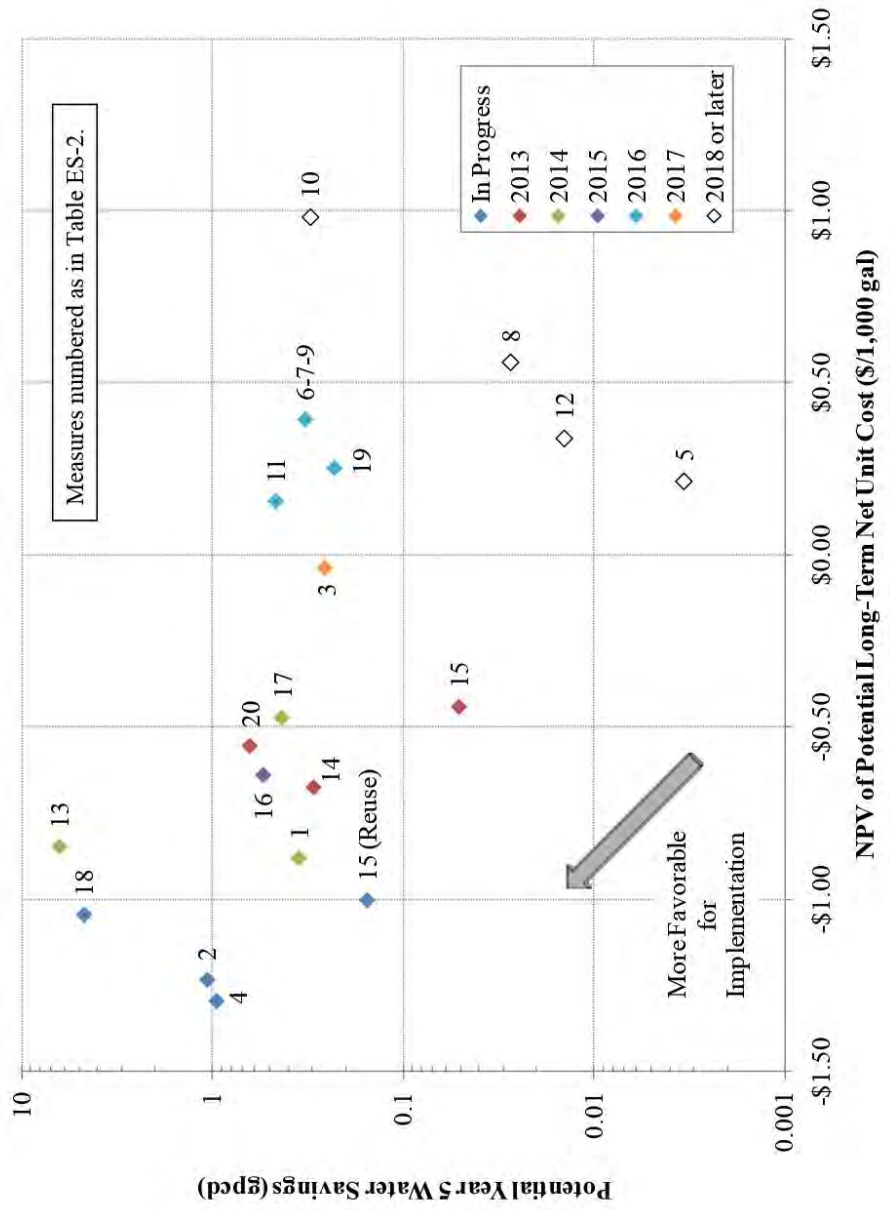
expand in later years to include high-efficiency clothes washer incentives and irrigation system incentives.

Table ES-2: Recommended Implementation Schedule for Evaluated Measures

	Measure	Year				
		2013	2014	2015	2016	2017
2	Toilets, natural replacement with HETs					
4	Residential clothes washers, natural replacement with HECWs					
15	Golf course reuse (natural implementation)*					
18	Water use reduction due to increases in real water price					
14	Public education (ET irrigation recommendations)					
20	Model conservation ordinance					
15	Golf course conservation					
13	Irrigation limits: maximum 2 times per week	X				
1	Residential high-efficiency toilet (HET) distribution/incentives	X				
1	*Create ICI device incentives menu:* High-efficiency toilet (HET) distribution/incentives	X				
17	Water loss reduction	X				
16	Model landscape ordinance	X	X			
11	*Add measure to ICI device incentives menu:* Irrigation system incentives			X		
11	Residential irrigation system incentives			X		
19	Wholesale customer assistance			X		
6 7 9	*Site-specific ICI customer program:* ICI customer water audits Site-specific ICI incentives ICI recognition program			X		
3	Residential high-efficiency clothes washer (HECW) incentives				X	
3	*Add measure to ICI device incentives menu:* High-efficiency clothes washer (HECW) incentives				X	
8	*Add measure to ICI device incentives menu:* Cooling tower incentives					X
10	Irrigation system evaluations	Y	Y	Y	Y	X
12	Rainwater harvesting incentives					
5	Pre-rinse spray valve retrofits					

*: Natural conversion of golf course irrigation from raw or potable water to reclaimed water.
X: TRWD staff will perform final planning of measures in the years before implementation.
Y: TRWD will continue its pilot irrigation system evaluation program.

Figure ES-6: Implementation Schedule, Cost-Effectiveness, and Water Savings



- TRWD should also create (by 2016) a "Site-Specific ICI Customer Program" that would provide in-depth assistance to individual ICI customers that desire it. This program would include the ICI customer water audits, site-specific ICI incentives, and ICI customer recognition measures. This program, and the ICI Device Incentives Menu described above, would complement the SmartWater ICI Audits program that Fort Worth implemented in 2010 by expanding audits to other cities and by making it more cost-effective for ICI water users to upgrade equipment. Examples of Fort Worth's success with this program are cited in Section 7.3.
- Since TRWD staff will be busy implementing the irrigation system incentives in 2016, the high-efficiency clothes washer incentives should be delayed until 2017.
- Although implementation of the irrigation system evaluations is not recommended until 2018 (after the five-year planning period), TRWD should begin final planning for this measure in 2017.
- Given the number of programs that TRWD must develop to meet the recommended schedule and the relatively low projected water savings from the pre-rinse spray valve retrofits, rainwater harvesting incentives, and cooling tower incentives, these measures are not recommended for implementation in the next five years.

Projected Water Savings, Benefits, and Costs (Section 11.2)

By 2017, the recommended implementation plan is projected to achieve the following water savings, benefits, and costs:

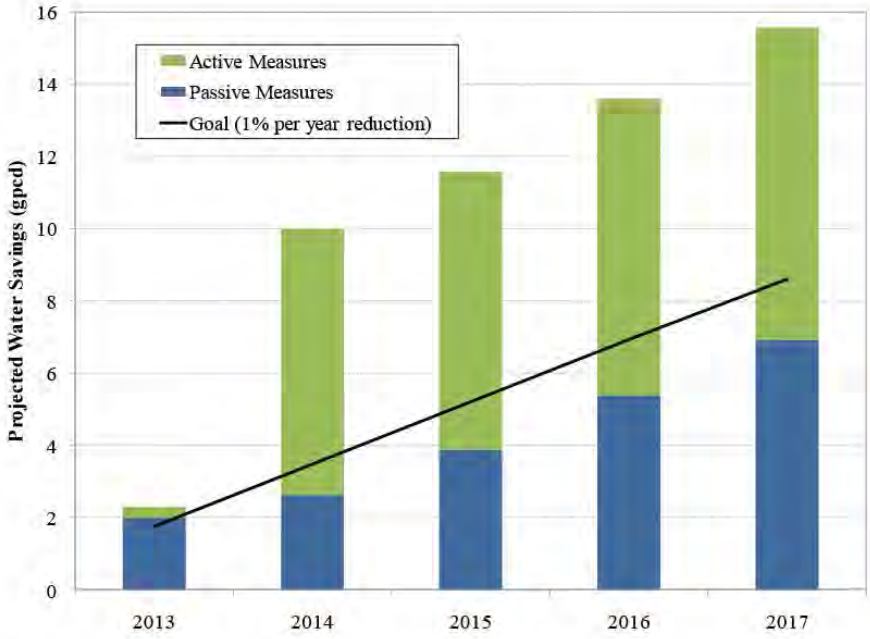
- Annual water savings of 30.1 mgd, which is 56 percent greater than the projected conservation savings (about 19.3 mgd) in the 2011 Region C Water Plan (Ref. 1).
- Annual per-capita water savings of 15.6 gpcd (Figure ES-7).
- Cumulative benefits of about $30.9 million (Figure ES-8).
- Cumulative costs to utilities of about $14.4 million (Figure ES-8).
- Cumulative benefit-cost ratio of about 2.1 (Figure ES-8).

The projected water savings from the implementation plan are in addition to the water savings that have already been achieved (an average of 23.2 mgd from 2007 through 2011). Therefore, it is projected that continuation of TRWD's existing water conservation measures and implementation of the recommended measures will achieve a total water savings of approximately 53.3 mgd compared to 2006 water use. At the projected five-year average per capita water demand (165.1 gpcd), these water savings would stretch the existing water supply enough to meet the needs of an additional 322,800 people by 2017. Placed in a different context, these water savings equal approximately 21 percent of the annual yield that TRWD could potentially obtain from the future Marvin Nichols Reservoir (Ref. 1).

The implementation plan would reduce projected per capita water use and, therefore, could either delay the need for additional water supplies or allow TRWD to downsize its share of future water supply projects. By 2030, the implementation plan could delay the need for additional water

supplies by as many as 9 years. As described in Section 10.5, construction of future water supplies is expected to be a cooperative effort between TRWD and other agencies. Since other agencies might not be able to defer construction of new water supply facilities, it has been assumed, for the purpose of evaluating the cost-effectiveness of potential water conservation measures, that TRWD will downsize its share of each planned future water supply according to the projected water conservation savings during a severe drought. Either way, the recommended water conservation implementation plan is cost-effective compared to developing additional water supplies.

Figure ES-7: Projected Per-Capita Water Savings



It is also assumed that Fort Worth and Arlington will continue their existing water conservation measures. Although TRWD will realize additional savings from these measures, additional savings from existing Fort Worth and Arlington measures have not been estimated and are not included in Figure ES-7.

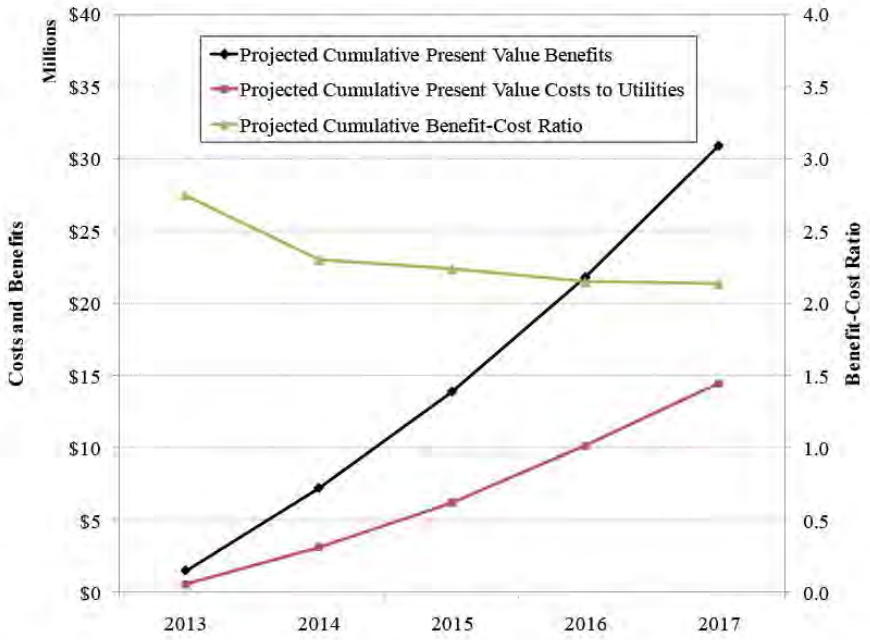
Recommended New Labor Resources (Section 11.3)

TRWD will implement some of the recommended water conservation measures (e.g., the ordinance measures) with existing staff members.[3] The remaining recommended measures will require new labor resources to effectively implement the Strategic Plan. New labor resources

[3] TRWD's customers may have to add staff members to implement some of the measures, particularly for ordinance enforcement.

could consist of additional TRWD staff members and/or retaining contractors. During the final planning stage for each recommended measure, TRWD will decide whether to add staff or retain contractors. Table ES-3 presents the overall new labor resource requirements in terms of full-time equivalent (FTE) positions, summarized by strategy and year. It is anticipated that additional labor resources equivalent to 6 FTEs will be required to effectively implement the recommended measures during the five-year implementation period.

Figure ES-8: Projected Present Value Benefits and Costs to Utilities



The recommended new labor resources have been based on customer participation assumptions and staff time required for similar programs at other utilities. Each of the recommended water conservation measures should be reviewed annually to verify that customer participation and the production capacity of the existing staff continue to warrant the recommended new labor resources.

Recommended TRWD Water Conservation Budgets (Section 11.4)

Recommended TRWD water conservation budgets are presented for the next five years in Table ES-4. TRWD budgets do not include costs borne by the wholesale customers, such as enforcement of regulations. The recommended budgets are designed to give TRWD the flexibility to either add staff or retain contractors to implement the recommended water conservation measures.

Table ES-3: Recommended New Labor Resources

Recommended Water Conservation Measures[a]	Recommended New Labor Resources (FTEs)[b,c]					
	2013	2014	2015	2016	2017	Five-Year Total
Toilet retrofits - Clerical		+1.50				+1.50
Irrigation system incentives - Clerical				+1.00		+1.00
Wholesale customer assistance - Application review, installation/savings verification				+0.25		+0.25
Site-specific ICI customer program - ICI water audits, installation/savings verification				+2.75		+2.75
Clothes washer retrofits - Clerical					+0.50	+0.50
TOTAL	**+0.00**	**+1.50**	**+0.00**	**+4.00**	**+0.50**	**+6.00**

[a] Some recommended water conservation measures/tasks are not shown, because it is assumed that TRWD will implement them using existing staff members.
[b] TRWD can either add staff members or retain contractors to implement these measures.
[c] Does not include staff increases for TRWD customers.

Table ES-4: Recommended TRWD Water Conservation Budget

Water Conservation Measures		Recommended TRWD Water Conservation Budget[a]				
		2013	2014	2015	2016	2017
2	Toilet natural replacement	$0	$0	$0	$0	$0
4	Clothes washer natural replacement	$0	$0	$0	$0	$0
15	Golf course reuse (natural implementation)	$0	$0	$0	$0	$0
18	Water use reduction - price	$0	$0	$0	$0	$0
14	Public education (ET)[c]	$2,000	$2,000	$2,000	$2,000	$2,000
20	Model conservation ordinance[b]	$0	$0	$0	$0	$0
15	Golf course conservation	$7,000	$7,000	$7,000	$8,000	$8,000
13	Irrigation limits 2/week[b]	-[c]	$0	$0	$0	$0
1	Toilet retrofits[d]	-[c]	$1,215,000	$1,237,000	$1,259,000	$1,282,000
17	Water loss reduction	-[c]	$122,000	$43,000	$44,000	$45,000
16	Model landscape ordinance[b]	-[c]	-[c]	$0	$0	$0
11	Irrigation system incentives	-	-	-[c]	$638,000	$666,000
19	Wholesale customer assistance	-	-	-[c]	$237,000	$229,000
6-7-9	Site-specific ICI customer program[d]	-	-	-[c]	$384,000	$395,000
3	Clothes washer retrofits	-	-	-	-[c]	$602,000
10	Irrigation system evaluations[d]	-[e]	-[e]	-[e]	-[e]	-[c,e]
Subtotal		***$9,000***	***$1,346,000***	***$1,289,000***	***$2,572,000***	***$3,229,000***
Continue existing TRWD programs		$1,649,000	$1,679,000	$1,710,000	$1,741,000	$1,773,000
Update Strategic Water Conservation Plan		-	-	-	$380,000	-
Total Water Conservation Budget		**$1,658,000**	**$3,025,000**	**$2,999,000**	**$4,693,000**	**$5,002,000**

[a] Costs inflated at an annual inflation rate of 1.8 percent per year (see Appendix J for discussion).
[b] Existing TRWD staff members will develop the model ordinances and coordinate customer adoption.
[c] Existing TRWD staff members will perform final planning and development of measures the year before implementation.
[d] TRWD will coordinate with existing Fort Worth and Arlington measures. The recommended budgets are for water conservation activities (toilet retrofits, ICI water audits, etc.) beyond those established and implemented by the Fort Worth and Arlington water conservation programs.
[e] Assumes that TRWD will continue its pilot irrigation system evaluation program. The pilot program is included in the "continue existing TRWD programs" line item.

The recommended budgets are the probable amounts that TRWD must spend on each strategy to achieve the projected water savings (Figure ES-7). In addition, TRWD should continue to fund its existing water conservation measures at existing levels (adjusted for inflation). The recommended total water conservation budgets range from $1.66 million in 2013 to $5.00 million in 2017.

Although it is recommended that TRWD proceed with implementation of recycled water projects to increase water efficiency, recycled water planning has been conducted separately from water conservation planning, and no budget recommendations for recycled water projects have been developed as part of the Strategic Plan.

APPENDIX H

TRWD WHITE PAPER: CONSIDERATION OF LIMITING OUTDOOR IRRIGATION SCHEDULES TO TWICE PER WEEK

FEBRUARY 2012

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APPENDIX H
TRWD White Paper: Consideration of Limiting Outdoor Irrigation Schedules to Twice Per Week

The water supplies we depend on are not endless resources. For one thing, drought conditions are just a part of life here in North Texas. And the number of people living in our region is expected to double in the next 50 years. That means the demand for water will certainly rise - and meeting that demand in a sustainable way will be a challenge.

In the past, building a reservoir was a sure answer to increasing water supplies. Today, there are no shortcuts - the alternatives for developing new water supplies are limited, expensive and time consuming. Couple that with the potential for severe droughts (like the one in 2011) and a steadily increasing population and conservation offers the quickest and cheapest way to relieve the strain on water supplies and meet the new water needs of our growing communities.

A good place to start saving water is by changing our outdoor irrigation habits. Outdoor water use, particularly lawn watering, can account for half or more of annual residential water use - and much more than that during the hot, dry Texas summers. In North Texas cities, average summer water demands can spike to more than 80% above average winter consumption.[1] It's a common scenario observed around the country.

The main culprit is a homeowner's tendency to over-water. Haley et al. (2007) showed that overall homeowners over-watered as much as 2-3 times the amount needed by plants, based on estimates of climate demand.[2] This study also reported that although homeowners use significantly less water in the winter months, when plant water requirements are at a minimum, they are still prone to over-irrigate.

One successful strategy to lower water use being pursued by communities nationwide is placing limitations on outdoor irrigation to no more than twice per week. The goal is to reduce excessive outdoor watering and water waste, especially during peak summer months when rain is scarce and demands are high. The savings here in North Texas would be tremendous - millions of gallons of highly treated drinking water per day; billions of gallons per year.

In September 2011, following the declaration of Stage 1 drought restrictions and twice per week watering limitations (Aug. 29, 2011), the water district observed an average decline in daily water demands of eight percent among its Tarrant County customers. Water use declined 35-45 million gallons per day after the restrictions were put in place compared to the daily water demands in the weeks leading up to Stage 1.

A study examining mandatory irrigation schedules during the 2002 Colorado drought found that restrictions were effective and produced significant water savings.[3] Net savings ranged from 15 to 55 percent on a per capita basis. The greatest savings were achieved by cities implementing the most aggressive restrictions. Cities with twice-a-week schedules reported a savings of 31 percent based on per capita use.[4]

Similarly in Florida, a literature review by Olmsted (2008) revealed that day-of-the-week watering restrictions were effective, in most cases.[5] In Hillsborough and Orange counties, utilities reported water use reductions of 17-18 percent; however no reductions were seen in Seminole County.[6]

In March 2011, the driest dry season in 80 years prompted South Florida water managers to declare a water shortage and impose two-day-per-week watering restrictions. The City of Stuart, Florida, already under a self-imposed two-day-a-week watering schedule in 2010, reported the restrictions were "proving to be water savers."[7] Daily consumption in Stuart dropped from 219 to 185 gallons on a per person basis - a water savings of more than 15 percent.

Day-of-week restrictions do not come without their drawbacks. Dukes et al. (2011) assert they may encourage over-watering on the allowed day. And they do not guarantee that water is being applied at the right time, in the right amount. So it is essential that we educate on proper irrigation application rates and scheduling to realize the best savings possible.

Concerns about plant survival in North Texas can be alleviated by the fact that landscapes don't need to be watered more than once per week during a majority of the year. And oftentimes watering isn't necessary at all.

The City of Frisco, Texas uses a weather station and rain gauges to provide residents with weekly watering recommendations based on climate conditions - something the Tarrant Regional Water District is working to put in place. During 2010, the city advised Frisco residents that their lawns didn't need any supplemental irrigation 25 out of 52 weeks.[8] Any outdoor irrigation taking place during those weeks was above what was required by landscapes and therefore wasteful. In addition, the city only recommended watering more than once per week during three of those weeks.

The situation was quite different for Frisco residents during the record drought of 2011. With rainfall amounts on the decline and heat on the rise, the city recommended a twice-per-week schedule 11 weeks during the year; a once per week schedule during 8 of those weeks; and that Mother Nature provided what landscapes needed the remaining 33 weeks of the year. The message to residents and to water suppliers is clear: we pour way too much water on our landscapes.

Another positive for plant survival using a twice-per-week watering schedule is our clay soil, the dominant soil type throughout the Metroplex. From a gardener's standpoint, it may be frustrating to work with. But from a landscape standpoint, clay soil retains moisture, which allows for longer spans between waterings.

Despite the evidence, placing limits on outdoor irrigation is not an easy choice. But it can also be easily argued that overwatering to the tune of millions of gallons a week isn't an acceptable choice either.

The Colorado study (Kenney, et al., 2004) suggests that "conservation programs based on mandatory, twice weekly landscape watering restrictions provide an attractive balance between saving water and limiting the impact on customers..."[9] But, to ensure the program's success will take a substantial level of commitment. It requires a willingness to enforce restrictions and a huge effort to promote and educate. Halich et al. (2005) showed that in Virginia the intensity in which water use restrictions are implemented clearly had in impact on lowering water use.[10]

By taking a regional approach to implementing twice-per-week watering restrictions, we can limit confusion and simplify the education of water users across all communities. The Tarrant Regional Water District is committed to reducing water waste and stretching our water supplies to meet the future water needs of our growing communities. Adopting a twice per week watering strategy will be an immense step towards embracing a more responsible use of our water resources.

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[1] McCormick, Lacy and Jennifer Walker, 2010. Sprayed Away Seven Ways to Reduce Texas' Outdoor Water Use. Wildlife Federation, Sierra Club. Retrieved January 26, 2012 from http://www.texaswatermatters.org/pdfs/sprayed%20away_report.pdf.

[2] Haley, Melissa B., Michael D. Dukes, Grady L. Miller, 2007. Residential Irrigation Water Use in Central Florida. Journal of Irrigation and Drainage Engineering 133(5): 427-434.

[3] Kenney, Douglas S., Roberta A. Klein, and Martyn P. Clark, 2004. Use and Effectiveness of Municipal Water Resources During Drought in Colorado. Journal of American Water Resource Association (JAWRA) 40 (1):77-87.

[4] Ibid.

[5] Dukes, Michael D., Laurie E. Trenholm, Ed Gilman, Chris J. Martinez, John L. Cisar, Thomas H. Yeager, Amy Shober and Geoffrey Denny, 2008. Reviewed May 2011. Frequently Asked Questions about Landscape Irrigation for Florida-Friendly Landscaping Ordinances. Environmental Horticulture Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Retrieved January 26, 21012 from https://edis.ifas.ufl.edu/wq142.

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[7] Seltzer, Alexandra, 2011, March 22. South Florida Water Managers Restrict Lawn Watering to Twice a Week. *Palm Beach Post*. Retrieved January 26, 2012 from http://www.tcpalm.com/news/2011/mar/22/south-florida-water-managers-restrict-lawn-to-a/.

[8] Hartwell, Gary, Public Works Director, City of Frisco. Personal communication. May 3, 2011.

[9] Ibid. 3.

[10] Halich, Greg, Kurt Stephenson, and Christiana Hilmer, 2005. The Effectiveness of Mandatory and Voluntary Water-Use Restrictions During DroughtDepartment of Agricultural and Applied Economics, Virginia Polytechnic Institute and State University. Prepared for American Agricultural Economic Association Annual Meeting, Providence, Rhode Island, July 2005.

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APPENDIX I

TWICE PER WEEK LANDSCAPE WATERING ORDINANCE ADOPTED BY FORT WORTH CITY COUNCIL

APRIL 8, 2014

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APPENDIX I

Twice per Week Landscape Watering Ordinance Adopted by the Fort Worth City Council, April 8, 2014

ORDINANCE NO. _____

AN ORDINANCE AMENDING CHAPTER 35, "WATER AND SEWERS", OF THE CODE OF THE CITY OF FORT WORTH (1986), AS AMENDED BY AMENDING ARTICLE I, "GENERAL", SUBSECTION (b) OF SECTION 23 "EMERGENCY AUTHORITY" BY REPLACING EXHIBIT A ATTACHED AND ADOPTING A REVISED DROUGHT CONTINGENCY/EMERGENCY WATER MANAGEMENT PLAN; BY AMENDING ARTICLE VI "LAWN AND LANDSCAPE IRRIGATION CONSERVATION", SECTION 35-151 "LAWN AND LANDSCAPE IRRIGATION RESTRICTIONS" TO MANDATE TWICE PER WEEK WATERING AND IRRIGATION AND TO PROVIDE FOR A VARIANCE PROCESS; PROVIDING THAT THIS ORDINANCE SHALL BE CUMULATIVE; PROVIDING A SEVERABILITY CLAUSE; PROVIDING A PENALTY CLAUSE; PROVIDING FOR PUBLICATION; AND PROVIDING AN EFFECTIVE DATE.

WHEREAS, the City Council finds that conservation of water and protection of water supplies are in the best interest of its citizens; and

WHEREAS, the City is required to submit updated water conservation and drought contingency and emergency water management plans to the Texas Commission on Environmental Quality (TCEQ) and the Texas Water Development Board by May 1, 2014 in accordance with Title 30 of the Texas Administrative Code, Chapter 288; and

WHEREAS, staff recommends that the City Council adopt the amended drought contingency and emergency water management plan referenced in Section 35-23(b) of the City Code; and

WHEREAS, in an effort to increase water conservation efforts and at the request of Tarrant Regional Water District, staff also recommends amending the Water and Sewers Code, Article VI Lawns and Landscape Irrigation Conservation, Section 35-151, to provide for permanent, year round twice per week watering and irrigation restrictions and a variance procedure; and

WHEREAS, the Water Conservation Plan proposes a goal of reducing the rolling five year average water consumption to a level of 160 gallons per capita per day by 2020 and 152 gallons per capita per day by 2025; and

WHEREAS, securing future water supplies will require proving to state permitting agencies that existing water supplies are being used efficiently.

NOW THEREFORE BE IT ORDAINED BY THE CITY COUNCIL OF THE CITY OF FORT WORTH, TEXAS:

SECTION 1.

Part II of the Code of the City of Fort Worth, Texas (1986), as amended, Chapter 35, "Water and Sewers", Article I, "In General", is hereby further amended to replace the Drought Contingency/Emergency Water Management Plan adopted in Section 23 "Emergency Authority", Subsection (b) as **Exhibit A** with the revised **Exhibit A** attached to this ordinance and incorporated herein for all purposes.

SECTION 2.

Part II of the Code of the City of Fort Worth, Texas (1986), as amended, Chapter 35, "Water and Sewers", Article VI, "Lawn and Landscape Irrigation Conservation"**,** Section 35-151, "Lawn and Landscape Irrigation Restrictions" is hereby further amended to read and be as follows:

SECTION 35-151. Lawn and Landscape Irrigation Restrictions.

(a) Except for hand watering, drip irrigation and the use of soaker hoses, a Person may only irrigate, water, or cause or permit the irrigation or watering of any lawn or landscape located on premises owned, leased, or managed by that Person (i) on a day designated as an outdoor water use day for the property's address as shown below; and (ii) between the hours of 12 midnight to 10 a.m. and 6 p.m. to 11:59 p.m. on such day.

(1) Residential addresses ending in an even number (0, 2, 4, 6 or 8) may water on Wednesdays and Saturdays.

(2) Residential addresses ending in an odd number (1, 3, 5, 7 or 9) may water on Thursdays and Sundays.

(3) All non-residential locations (apartment complexes, businesses, industries, parks, street and/or roadway medians, etc.) may water on Tuesdays and Fridays.

(b) Except for hand watering, drip irrigation and the use of soaker hoses, a Person commits an offense if that Person irrigates, waters, or causes or permits the

irrigation or watering of any lawn or landscape located on premises owned, leased, or managed by that Person between the hours of 10:00 a.m. and 6:00 p.m.

(c) Except for hand watering, drip irrigation and the use of soaker hoses, a Person commits an offense if that Person irrigates, waters, or causes or permits the irrigation or watering of any lawn or landscape located on premises owned, leased, or managed by that Person on a day that is not designated as an outdoor water use for that property address as shown in subsection (a) above.

(d) A Person commits an offense if a Person knowingly or recklessly irrigates, waters, or causes or permits the irrigation or watering of a lawn or landscape located on premises owned, leased or managed by the Person in a manner that causes:

(1) a substantial amount of water to fall upon impervious areas instead of a lawn or landscape, such that a constant stream of water overflows from the lawn or landscape onto a street or other drainage area; or

(2) an irrigation system or other lawn or landscape watering device to operate during any form of precipitation.

(e) A Person commits an offense if, on premises owned, leased, or managed by that Person, a Person operates a lawn or landscape irrigation system or device that:

(1) has any broken or missing sprinkler head; or

(2) has not been properly maintained in a manner that prevents the waste of water.

(f) Affirmative Defenses

(1) It shall be an affirmative defense to prosecution of an offense in section 35- 151 (a) that at the time such Person irrigates, waters, or causes or permits the irrigation or watering of any lawn or landscape, such activity was for the purpose of:

(A) dust control of a sports field; or

(B) the maintenance, repair, or testing of an irrigation system.

(2) The activity described in subsection f (1) (A) and (B) may only occur within a period of two (2) days no more than once every thirty (30) days. Any such activity requiring a longer period or greater frequency shall require a variance as provided by subsection (g).

(g) Variances

(1) The water department director or official designee may grant variances to the twice per week watering and irrigation restrictions and schedule, if one or more of the following conditions are met:

(A) Failure to grant such a variance would cause an emergency condition adversely affecting health, sanitation, or fire safety for the public or the Person requesting the variance;

(B) Compliance with the watering and irrigation restrictions and/or schedule cannot be accomplished due to technical or other limitations; or

(C) Alternative methods that achieve the same level of reduction in water use can be implemented.

(2) The water department director or official designee may grant variances to allow for establishment of hydromulch, grass sod, or grass seed for new lawns.

(3) Variances shall be granted or denied at the discretion of the water department director or official designee. All petitions for variances shall be in writing and shall include the following:

(A) Name and address of the petitioner(s);

(B) Purpose of the water use;

(C) Specific provisions from which relief is requested;

(D) Detailed statement of the adverse effect of the provision from which relief is requested;

(E) Description of the relief requested;

(F) Period of time for which the variance is sought;

(G) Alternative measures that will be taken to reduce water use; and

(H) Other pertinent information requested.

(h) A Person who irrigates, waters, or causes or permits the irrigation or watering by use of an alternative water source such as a well, reclaimed or reused water, or water from the Trinity River is exempt from prosecution if that Person has:

(1) Registered such alternative water source with the City;

(2) Provided sufficient proof to the water department director that the alternative water source is from a well, reclaimed or reused water or from the Trinity River and has allowed inspection by the water department director if deemed necessary; and

(3) Complied with the City's Backflow and Cross-connection Control Program and City Code Sections 12.5-525 through 12.5-599.

SECTION 3.
CUMULATIVE PROVISIONS

This ordinance shall be cumulative of all provisions of ordinances and of the Code of the City of Fort Worth, Texas (1986), as amended, except where the provisions of this ordinance are in direct conflict with the provisions of such ordinances and such Code, in which event conflicting provisions of such ordinances and such Code are hereby repealed.

SECTION 4.
SEVERABILITY CLAUSE

It is hereby declared to be the intention of the City Council that the phrase, clause, sentence, paragraph or section of this ordinance are severable and, if any phrase, clause, sentence, paragraph or section of this ordinance shall be declared unconstitutional by the valid judgment or decree of any court of competent jurisdiction, such unconstitutionality shall not affect any of the remaining phrases, clauses, sentences, paragraphs and sections of this ordinance, since the same would have been enacted by the City Council without the incorporation in this ordinance of any such unconstitutional phrase, clause, sentence, paragraph or section.

SECTION 5.
PENALTY CLAUSE

Any person, firm or corporation who violates, disobeys, omits, neglects or refuses to comply with or who resists the enforcement of any of the provisions of this ordinance shall be fined not more than two thousand dollars ($2,000.00) for each offense. Each day that a violation is permitted to exist shall constitute a separate offense.

SECTION 6.
RIGHTS AND REMEDIES

All rights and remedies of the City of Fort Worth, Texas, are expressly saved as to any and all violations of the provisions of the ordinances amended herein, which have accrued at the time of the effective date of this ordinance and, as to such accrued violations and all pending litigation, both civil and criminal, whether pending in court or not, under such ordinances, same shall not be affected by this ordinance but may be prosecuted until final disposition by the courts.

SECTION 7.
PUBLICATION

The City Secretary of the City of Fort Worth, Texas, is hereby directed to publish the caption of this ordinance for two (2) days in the official newspaper of the City of Fort Worth, Texas, as authorized by Section 2, Chapter XXV of the Charter of the City of Fort Worth, Texas and by Section 52.013, Texas Local Government Code.

SECTION 8.
EFFECTIVE DATE

This Ordinance shall take effect upon adoption and publication as required by law.

APPROVED AS TO FORM AND LEGALITY:

By: _____
Christa R. Lopez-Reynolds
Senior Assistant City Attorney

ADOPTED:_____

EFFECTIVE:_____

APPENDIX J

WATER CONSERVATION FACT SHEET INCLUDED IN APPENDIX A OF TRWD INTEGRATED WATER SUPPLY PLAN (2013)

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APPENDIX J

Water Conservation Fact Sheet included in Appendix A of the TRWD Integrated Water Supply Plan

Water Conservation

Description

In planning and developing new water supplies, water conservation strategies across Texas will play a vital role in meeting the projected water needs throughout the state. The 2012 State Water Plan reports that 12 percent of future water needs in Region C will be met through municipal conservation.[1] From a cost standpoint, water conservation is the most cost-effective alternative for meeting new water demands.

The Texas Water Code defines water conservation as "those practices, techniques, and technologies that will reduce the consumption of water, reduce the loss or waste of water, improve the efficiency in the use of water, or increase the recycling and reuse of water so that a water supply is made available for future or alternative uses" (§11.002 (a) (8) (B)). The end result is lower per capita demands and less pressure on existing water supplies. Meaningful reductions in water loss and water waste, and improvements in water efficiency can help TRWD in many ways. Over time, conserving water on a daily basis:

- extends the life of existing supplies to meet new water demands
- slows the drain on reservoirs making more water available during times of drought
- reduces peak supply requirements, which reduces wear and tear on existing infrastructure
- defers increases in capital and operating cost for existing systems, and
- delays the need for developing new water supplies.

Tarrant Regional Water District recognizes the benefits of using water and energy resources more efficiently. In order to maximize the use of existing water resources, TRWD is pursuing a menu of active water conservation measures, not just in times of drought but year-round. Some of the savings TRWD is observing today are due to passive measures that are occurring naturally, such as the replacement of older fixtures and appliances in existing homes with newer, more efficient models. The water district anticipates that the combination of active and passive conservation measures will lead to long-term, permanent reductions in per capita demand. Lower per capita demands is a trend being observed across the country. A national study found that residential water use over the last 30 years has declined at an average rate of 0.44 percent annually.[2]

TRWD is committed to water conservation and has established a program that is generating an annual savings that can be measured in billions of gallons. Water

conservation will continue to play a vital role in the district's long-term water supply strategy.

Strategic Water Conservation Plan

TRWD's Strategic Water Conservation Plan[3] ("Strategic Plan") is designed to serve as a roadmap for developing and implementing water conservation strategies and to provide a way to evaluate their success. The goals of TRWD's water conservation program include reducing per capita use, reducing seasonal peak demands, and reducing water loss and water waste. The target for improving water efficiency is a one percent per year reduction in average water use over a five-year planning period.

The Strategic Plan evaluated the cost and effectiveness of twenty water conservation measures. These particular strategies were screened and selected because of their water savings potential, customer feedback, and their applicability to the majority of customers in the water district's service area. The top six measures projected to generate the highest per capita savings included a combination of active and passive measures[4]:

- Twice per week irrigation limits 6.20 gpcd
- Water use reductions due to price increases 4.74 gpcd
- Natural toilet replacement 1.07 gpcd
- Clothes washer natural replacement 0.96 gpcd
- Model water conservation ordinance 0.62 gpcd
- Wholesale customer water loss reduction 0.42 gpcd

By 2017, the Plan estimates the total per capita savings generated by these measures will be 14.01 gallons per day. These six measures represent 89.8 percent of all the water savings outlined in the Plan.

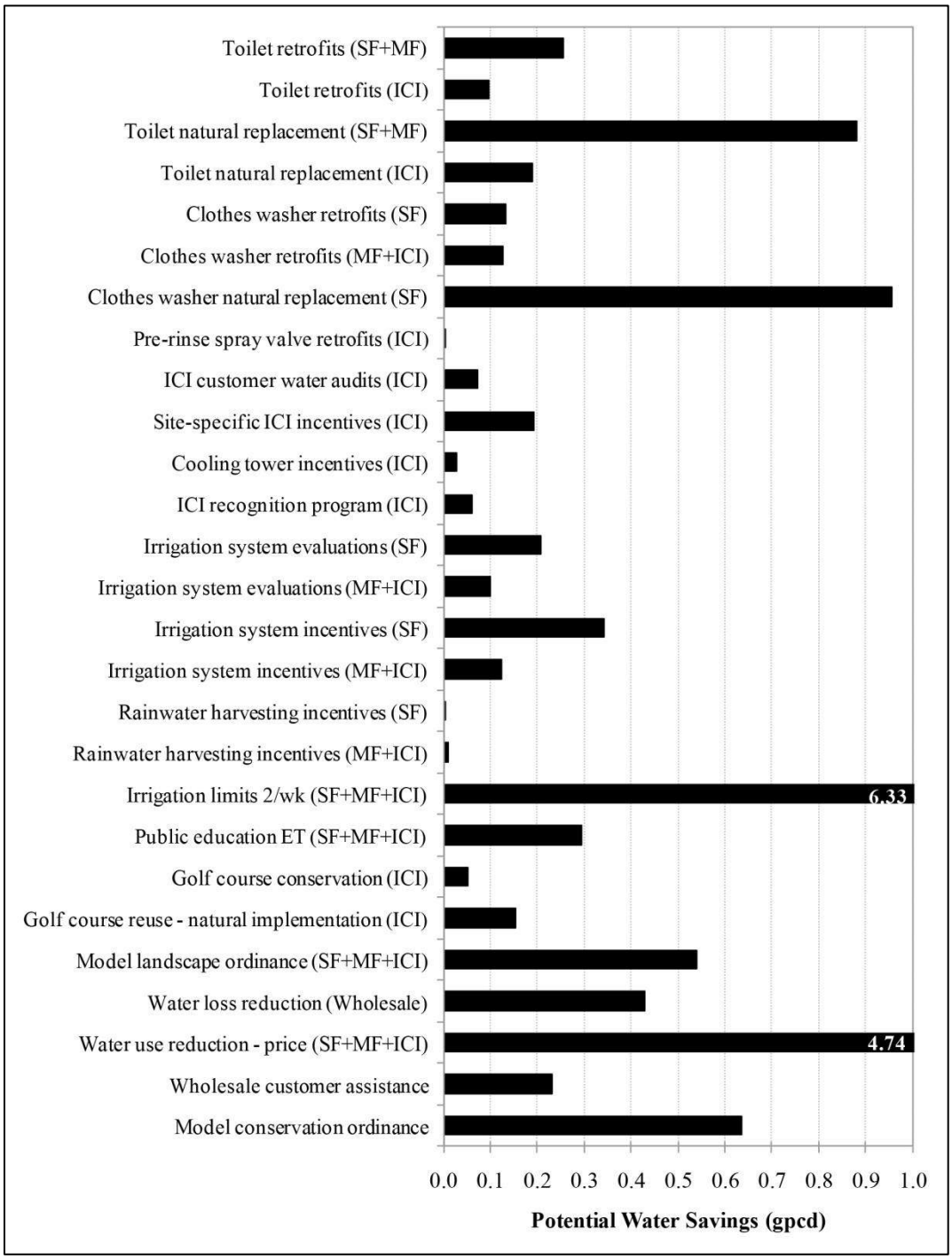

Figure 1: Potential Per Capita Water Savings in Year 5 of the Strategic Plan
Each measure was evaluated by separate categories. SF represents single family residences; MF represents multi-family dwellings, such as apartment complexes; and ICI covers industrial, commercial, and institutional establishments.

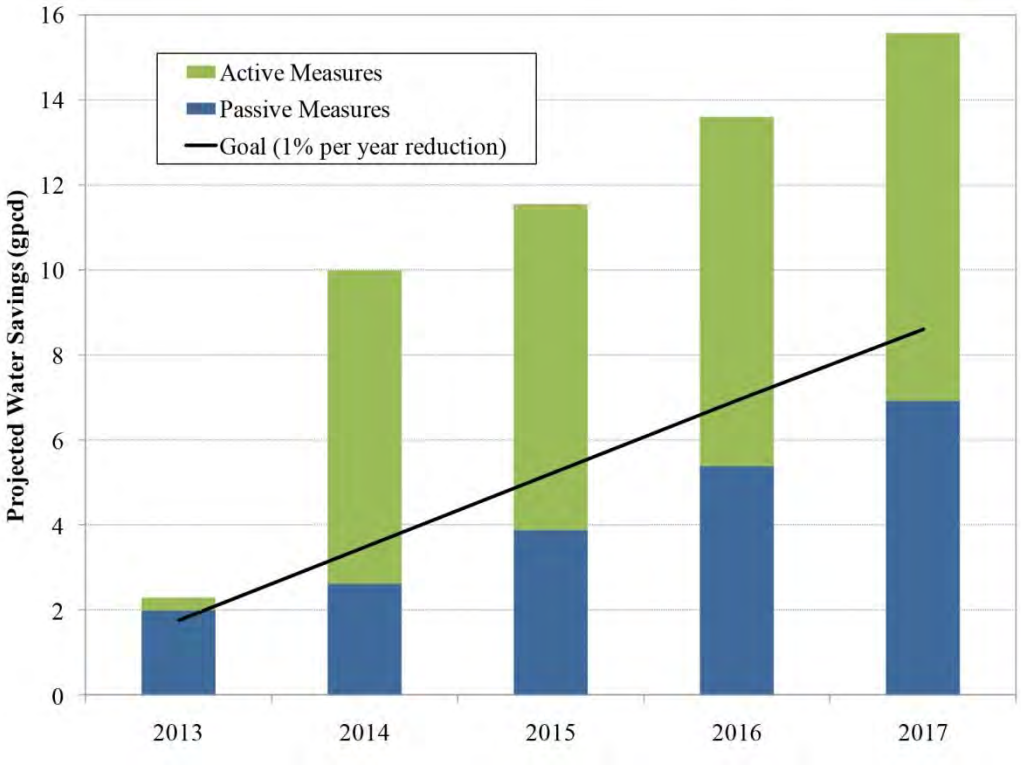

Figure 2: Projected Per Capita Water Savings

Water Conservation Savings

The Strategic Plan includes a model of TRWD annual demands. The model was calibrated using water demands among the district's primary customers from 1997 to 2004, before water conservation measures were put in place. The model is used to predict TRWD annual demands without conservation and allows for a comparison with actual demands. The difference between the model's projected demands and actual consumption is assumed to be savings.

Here are some highlights of the savings achieved from ongoing conservation efforts from 2007 through 2012:

- A cumulative savings of 72.29 billion gallons or 221,859 acre-feet.
- Annual savings ranging from 8.0 to 21.9 billion gallons, with savings on an annual basis averaging 12.0 billion gallons.
- An average savings of 33.0 mgd. At the 2012 rolling average consumption rate (180 gpcd), 33.0 mgd could supply an additional 183,300 people.
- An average savings of 36,977 acre-feet per year, which is 70 percent of the firm yield of the proposed Cedar Creek indirect reuse project.

Savings among the district's primary customers in 2012 alone was nearly 22 billion gallons – about 20 percent of the predicted demands without conservation. A chart illustrating the projected water demands versus actual demands and a table of the estimated annual savings is included below.

Table 1: Estimated Annual Savings Due to Ongoing Water Conservation Efforts and Drought Contingency Measures, 2007-2012

Year	Billion Gallons	Acre-Feet
2007	8.97	27,534
2008	7.95	24,395
2009	9.44	28,979
2010	9.65	29,612
2011	14.43	44,269
2012	21.86	67,070
Total Savings	**72.29**	**221,859**

Note: Some savings in 2011 and 2012 can be attributed to the implementation of Stage 1 drought contingency measures, which were in effect from August 29, 2011 through May 3, 2012. The Strategic Plan estimates Stage 1 drought measures lowered demands by an additional 5.76 billion gallons during that timeframe.

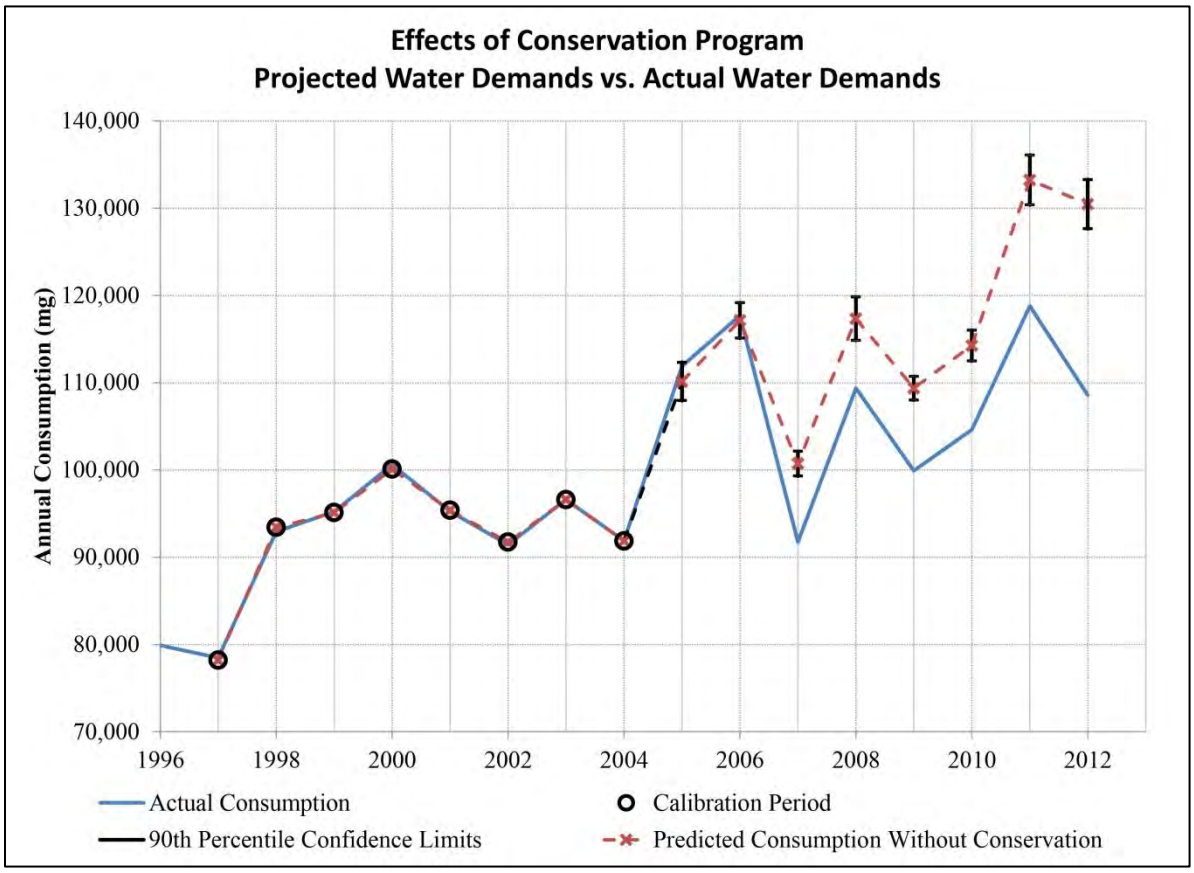

Figure 3: Estimated Consumption of TRWD's primary customers without Conservation Versus Actual Consumption

Projected Water Savings, Benefits, and Costs

Implementing all of the water conservation strategies over the next five years would nearly double the water savings achieved so far. The combined savings would amount to more than 63 mgd when compared to 2006 water use. By 2017, implementing the recommendations described above would produce the following water savings, benefits, and costs:[5]

- Annual water savings of 30.1 mgd, which is 56 percent greater than the conservation savings projected in the 2011 Region C Water Plan.
- Annual per capita water savings of 15.6 gpcd, putting TRWD on course to surpass its 2018 total water use goal of 166 gpcd.
- Cumulative present value benefits of about $30.9 million.
- Cumulative present value costs to utilities of about $14.4 million

Full implementation of all measures in the Plan would increase TRWD's water conservation budget from its current level of $1.89 million to $5.0 million annually by 2017. The projected annual water savings would be 33,700 acre-feet, enough to serve

the needs of an additional 180,000 people using existing supplies. The potential water savings through 2060 would be more than 2.84 million acre-feet. [6]

Saving water comes with economic benefits, as well. The potential economic benefit from all the evaluated water conservation measures has a present value of $8.0 to 10.0 million, and today's funding of water conservation measures will provide a substantial long-term return on the investment. The net present value of the potential long-term benefits from all evaluated measures through 2060 is projected to be $987.6 million.[7]

The other advantages of supporting a successful water conservation program include:[8]

- Extending the life of existing supplies and delaying the need for new water supplies.
- Reducing peak supply requirements and extending the life of existing infrastructure. Since water system infrastructure is sized to meet peak demands, reducing the peaks also delays the need to expand facilities.
- Positioning TRWD to obtain future water rights. To secure authorization of an interbasin transfer, the applicant must have "developed and implemented a water conservation plan that results in the highest practicable levels of water conservation…"[9]
- Positive environmental effects, improved customer good will, continued growth and economic development, and a reduction in TRWD's carbon footprint.

TRWD and Dallas Outreach Campaign

Since 2007, the water district has stepped up its commitment to water conservation and budgeted $9.49 million (through FY 2013) for its programs and staff support. Approximately $6.24 million or 66 percent of those funds were used to develop and promote a joint public outreach campaign with Dallas Water Utilities. The combined contribution from both entities for media outreach and production costs amounts to more than $2.0 million annually. By coordinating regional outreach to promote water conservation, TRWD doubles its advertising for the money spent.

The biggest focus of the water district's conservation efforts has been on reducing excessive outdoor water use. On an annual basis the four primary customers use 31 percent to 50 percent of their water for seasonal uses depending on climatic conditions.[10] In most years, outdoor water consumption exceeds 40 percent of total water demands. And studies have shown that overall homeowners over-water as much as 2-3 times the amount needed by plants, based on climate conditions. Changing outdoor irrigation habits and reducing excessive outdoor water use offers an opportunity to save tremendous amounts of water.

The investment in water conservation outreach and other programs is paying off. A simple comparison of the water savings and the water conservation budget from 2007 to 2012 indicates the unit cost of the savings to be $0.11 per thousand gallons.

Water Conservation as a Supply Strategy

Water supplies are not endless resources. The number of people living in our region is expected to nearly double in the next 50 years. That means the demand for water will rise – and meeting that demand in a sustainable way will be a challenge.

Conservation is a viable water supply strategy. It maximizes the use of current supplies to help meet the water needs of growing communities. And there are signs the water district's conservation efforts are increasing the efficient use of its water resources:

- In 2011, water consumption during the one-year drought of record among its primary customers increased less than 4,000 acre-feet compared to 2006, despite an increase in population of about 100,000 residents.
- In 2012, TRWD's primary customers used 67,000 acre-feet less than predicted based on climate conditions and a model of water use before water conservation measures were put in place.
- The savings in 2012 alone was slightly more than the firm yield of the Richland-Chambers indirect reuse project, which is 63,000 acre-feet.
- TRWD estimates the average water savings between 2007 through 2012 was 33.0 mgd. At today's consumption rate, 33.0 mgd could supply an additional 183,300 people with existing supplies.

When people use less water, it frees up more water (and energy) for us to accommodate the needs of more people. And the overall reduction in demands and lower peaking requirements should allow the water district to extend the horizon for developing new supplies.

The water district anticipates the savings to continue in the coming years. Since 2002, TRWD's average per capita water use has decreased more than eight percent. The declining trends in water consumption are not an accident. They are a combination of numerous influences, including the availability of more water efficient fixtures and appliances, pricing structures at the retail level, water utility leak detection and water loss programs, and an ongoing public education and outreach campaign.

The Tarrant Regional Water District embraces, and will continue to invest in, water conservation as a supply strategy. It's one of the most economical ways for TRWD to meet the needs of its customers. Using the water we have available today more efficiently means we will have more water to share with new residents, new businesses, and for future economic growth.

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[6] Ibid. p. 98

[7] Ibid. p. 103

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[9] Freese and Nichols, Inc. Alan Plummer Associates, Inc., CP&Y, Inc. and Cooksey Communications, Inc., 2011 Region C Water Plan: prepared for the Region C Water Planning Group, Fort Worth, October 2010.

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APPENDIX K

TARRANT REGIONAL WATER DISTRICT BOARD RESOLUTION ADOPTING THE WATER CONSERVATION AND DROUGHT CONTINGENCY PLAN

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Tarrant Regional Water District
Board Resolution Adopting the Water Conservation and Drought Contingency Plan

WHEREAS, Tarrant Regional Water District, a Water Control and Improvement District (the "District"), as a wholesale water supplier, is required by the Texas Commission on Environmental Quality to develop (a) a water conservation plan pursuant to Title 30, Part 1, Chapter 288, Subchapter A, Rule 288.5 of the Texas Administrative Code and (b) a drought contingency plan pursuant to Title 30, Part 1, Chapter 288, Subchapter B, Rule 288.22 of the Texas Administrative Code; and

WHEREAS, the District recognizes the importance of a long-term approach to conserving water supplies by reducing the volume of water withdrawn from its reservoirs, reducing the loss or waste of water, improving water use efficiency, and increasing the recycling and reuse of water; and

WHEREAS, the plan provides significant benefits to the District, its customers, and the public they serve through the implementation of year-round water saving strategies to increase District reservoir storage volumes during wet or dry weather conditions.

NOW, THEREFORE, be it resolved by the Board of Directors of the District that the Water Conservation and Drought Contingency Plan attached hereto as Exhibit A is adopted as the controlling policy of the District.

TARRANT REGIONAL WATER DISTRICT, a
Water Control and Improvement District

By: Victor W. Henderson

Victor W. Henderson
President, Board of Directors

ATTEST:

Martha V. Leonard

Martha V. Leonard
Secretary, Board of Directors

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APPENDIX L

LETTERS TO REGION C AND REGION D WATER PLANNING GROUPS

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APPENDIX L

Letters to Region C and Region D Water Planning Groups

Date

Mr. Jim Parks
Chair, Region C Water Planning Group
North Texas Municipal Water District
P.O. Box 2408
Wylie, TX 75098

Dear Mr. Parks:

Enclosed please find a copy of the recently adopted water conservation and drought contingency plan for the Tarrant Regional Water District. I am submitting a copy of this plan to the Region C Water Planning Group in accordance with the Texas Water Development Board and Texas Commission on Environmental Quality rules. The Board of the Tarrant Regional Water District adopted the attached plan on May 20, 2014.

Sincerely,

James M. Oliver
General Manager
Tarrant Regional Water District

Date

Mr. Bret McCoy
Chair, Region D Water Planning Group
C/O Northeast Texas Municipal Water District
P.O. Box 955
Hughes Springs, TX 75656

Dear Mr. McCoy:

Enclosed please find a copy of the recently adopted water conservation and drought contingency plan for the Tarrant Regional Water District. I am submitting a copy of this plan to the Region D Water Planning Group in accordance with the Texas Water Development Board and Texas Commission on Environmental Quality rules. The Board of the Tarrant Regional Water District adopted the attached plan on May 20, 2014.

Sincerely,

James M. Oliver
General Manager
Tarrant Regional Water District

APPENDIX M

RESULTS OF CLIMATIC MODELING STUDY BY HYDROSPHERE RESOURCE CONSULTANTS TO PREDICT IMPACTS ON TRWD WATER SUPPLIES AND PROJECTED WATER SAVINGS OF THE CONSERVATION AND DROUGHT CONTINGENCY PLAN

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APPENDIX M

Results of climatic modeling study by Hydrosphere Resource Consultants to predict impacts on TRWD water supplies and projected water savings of the water conservation and drought contingency plan

Background

Tarrant Regional Water District made a decision to review its current water conservation and drought contingency plan after experiencing one of the worst two-year droughts in North Texas history. The extended period of dry weather, which lasted from winter 2005 to spring 2007, offered TRWD an opportunity to observe the effectiveness of the current plan under severe drought conditions. The goal was to determine what effect the plan would have on extending water supplies for the 1.7 million people who ultimately rely on TRWD for their water.

The conclusions of an internal review of the current water conservation and drought contingency plan were disappointing. TRWD engineers determined that it had little effect on extending water supplies and that the plan made less than one percent (1%) difference in total storage volume of the TRWD reservoir system. The plan does not require the implementation of any mandatory water conserving measures until combined storage capacity in the TRWD reservoir system drops to 50%. After verifying the inadequate responses of the current plan, TRWD sought expert outside assistance to establish a realistic set of trigger points and responses that would significantly extend water supplies in times of drought.

The Study

Tarrant Regional Water District employed Hydrosphere Resource Consultants, an engineering firm in Boulder, Colorado, to evaluate the effectiveness of various water conservation and drought contingency strategies based on a series of simulated weather patterns. Hydrosphere examined hundreds of climatic scenarios to predict their impact on reservoir volumes within the TRWD system; to compare water savings of drought contingency plans at selected trigger points; and to determine the frequency that reservoir storage volumes would reach the drought stage triggers.

Hydrosphere based its statistical analysis of the effects of weather patterns on reservoir levels using the Monte Carlo method. The simulated climatic conditions randomly generated by the Monte Carlo technique were based on existing North Texas weather patterns from 1940 to 2002. Each weather pattern was classified as average, dry, or drought, with wet years included in the average group. The weather patterns consisted of rainfall and evaporation data. The climatic modeling was based on the cycle of average, dry, and drought years experienced over the 43-year period. The analyses produced robust estimates of reservoir volumes, the frequency of their occurrence, and the water savings that would be achieved by implementing drought stages based on reservoir capacities of 75, 60, and 45 percent.

The projected water savings is based on a reduction in water use achieved through the implementation of outdoor watering restrictions at each stage of the new water conservation and drought contingency plan. Here is a recap of the restrictions by drought stage:

- At 75% capacity (Stage 1, Water Watch) landscape watering would be reduced to twice per week.
- At 60% capacity (Stage 2, Water Warning) landscape watering would be reduced to once per week.
- At 45% capacity (Stage 3, Emergency Water Use) landscape watering would be banned.

The model produced by the Hydrosphere study assumed that demands would decrease by 10% under the twice per week outdoor watering schedule; consumption would drop an additional 10% with once per week watering; and that no outdoor watering would result in another 20% reduction in demands.

Study Results: Estimated Savings of the New Plan

The table below depicts the estimated savings that would be achieved once the trigger points are reached and the drought stages are activated. The volume of water saved is based on anticipated demands in 2010 and 2020, which are expected to average 29,000 and 35,000 acre-feet per month, respectively.

Estimated Savings at Selected Trigger Points of Proposed Water Conservation and Drought Contingency Plan (in acre-feet)

Drought Stage	Percent conservation storage	2010 demands	2020 demands
Stage 1, Water Watch	Supply = 75%	2,035	1,973
Stage 2, Water Warning	Supply = 60%	22,388	30,448
Stage 3, Emergency Water Use	Supply = 45%	43,788	58,548

- The estimated savings at each drought stage represents an increase in the amount of water available in the TRWD reservoir system under the new water conservation and drought contingency plan versus having no plan in place.
- When compared to the plan currently in effect, implementing the new plan would stretch available water supplies by almost two months under Stage 3 drought conditions. The savings is even more dramatic when both plans are compared under the worst anticipated drought conditions.
-

Study Results: Comparison of Current and New Plans Under Severe Drought Conditions

Under the current water conservation and drought contingency plan, once a week watering restrictions are not required until storage in the TRWD reservoir system reaches 50% maximum capacity; and outdoor watering is not banned until reservoirs bottom out at 25% maximum capacity. The table below compares the water savings that would be achieved by the current versus the new plan under the worst simulated drought conditions over a seven-year period.

Comparison of Water Savings (in acre-feet) Between the Current and New Water Conservation and Drought Contingency Plans Based on 2010 and 2020 Demands		
Year	Current Plan (Triggers = 50 and 25%)	New Plan (Triggers = 75, 60, 45%)
2010	18,300	62,600
2020	22,000	98,500

- In the case of a severe drought, implementing the new water conservation and drought contingency plan will increase water supplies by a projected three to four times the amount that would have been available under the current plan.
- The water savings achieved by the current plan represents less than a one month supply of the demands anticipated in 2010 and 2020.

Study Results: Probability of Reaching Trigger Points with the New Water Conservation and Drought Contingency Plan in Effect

The table below shows the probability of reaching the combined TRWD reservoir storage capacities of 75%, 60%, and 45%.

Frequency or probability of combined TRWD reservoir storage capacities			
Drought Stage	Percent conservation storage	2010 demands	2020 demands
Stage 1, Water Watch	Supply = 75%	20%	26%
Stage 2, Water Warning	Supply = 60%	4%	6%
State 3, Emergency Water Use	Supply = 45%	0.3%	0.6%

- The Hydrosphere study concluded that the Stage 1 drought conditions would prevail roughly 20% of the time (or about once every five years) in 2010, and roughly 26% of the time (or an average of about once every four years) in 2020.

- Stage 2 drought conditions and the implementation of mandatory once a week outdoor watering restrictions would take place approximately once every 25 and 17 years, based on demands in 2010 and 2020, respectively.

- The odds of implementing the outdoor watering ban, which goes into effect with Stage 3 drought conditions, are once every 333 and 167 years, based on demands in 2010 and 2020, respectively.

Conclusion

Revising the current water conservation and drought contingency plan is necessary in order to achieve meaningful increases in TRWD reservoir storage volumes during extended periods of dry weather. Studies have shown that outdoor residential water use, especially in hot dry areas like Texas, can account for up to 50% or more of the total volume of water consumed annually per household. By establishing new trigger points before reservoirs drop to critical levels of 50% or less, TRWD and its customers are taking a proactive approach to preserving water supplies.

The outdoor watering restrictions called for in the first two stages of the new water conservation and drought contingency plan (reservoir storage capacities of 75 and 60 percent) should have a negligible impact on residential landscapes. They simply require residents to be more efficient in their outdoor water use. The ban on outdoor watering during a Stage 3 drought will likely have an impact on a majority of landscapes, especially during the summer, however landscapes with drought-tolerant plants will survive. More importantly, the plan will help maintain adequate water supplies for domestic water, sanitation, and fire protection needs in a manner that protects and preserves public health, welfare and safety.

In light of the projected increases in the North Texas population, there is a need to ensure water supplies will meet community needs not only during severe droughts, but over the long-term. The conservation lifestyle is not a choice anymore. It is an essential component of a paradigm shift in water use that will allow TRWD and its customers to achieve the goals set forth in the new water conservation and drought contingency plan:

- To conserve the available water supply in times of drought and emergency
- To minimize the adverse impacts of water supply shortages
- To reduce water consumption from the levels that would prevail without conservation efforts.
- To reduce the loss and waste of water.
- To improve efficiency in the use of water.

APPENDIX N

TEXAS WATER CODE SECTION 11.039

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APPENDIX N

Texas Water Code Section 11.039

§ 11.039. Distribution of Water During Shortage

(a) If a shortage of water in a water supply not covered by a water conservation plan prepared in compliance with Texas Natural Resource Conservation Commission or Texas Water Development Board rules results from drought, accident, or other cause, the water to be distributed shall be divided among all customers pro rata, according to the amount each may be entitled to, so that preference is given to no one and everyone suffers alike.

(b) If a shortage of water in a water supply covered by a water conservation plan prepared in compliance with Texas Natural Resource Conservation Commission or Texas Water Development Board rules results from drought, accident, or other cause, the person, association of persons, or corporation owning or controlling the water shall divide the water to be distributed among all customers pro rata, according to:

(1) the amount of water to which each customer may be entitled; or

(2) the amount of water to which each customer may be entitled, less the amount of water the customer would have saved if the customer had operated its water system in compliance with the water conservation plan.

(c) Nothing in Subsection (a) or (b) precludes the person, association of persons, or corporation owning or controlling the water from supplying water to a person who has a prior vested right to the water under the laws of this state.

Amended by Acts 1977, 65th Leg., p. 2207, ch. 870, § 1, eff. Sept. 1, 1977.

Amended by Acts 2001, 77th Leg., ch. 1126, § 1, eff. June 15, 2001.

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TRWD Part C #45 d

	PROJECTED 2016	PROJECTED 2017	PROJECTED 2018	PROJECTED 2019	PROJECTED 2020	PROJECTED 2021	PROJECTED 2022	PROJECTED 2023	PROJECTED 2024	PROJECTED 2025	PROJECTED 2026	PROJECTED 2027	PROJECTED 2028	PROJECTED 2029	PROJECTED 2030	PROJECTED 2031
SYSTEM OPERATIONS																
Operations and Maintenance	39,079,343	41,424,104	46,209,550	48,982,123	58,921,050	62,456,313	66,203,692	70,175,913	74,386,468	78,849,656	83,580,636	88,595,474	93,911,202	99,545,874	105,518,627	111,849,745
Pumping Power (53)	23,500,000	24,205,000	24,931,150	25,679,085	26,449,457	27,242,941	28,060,229	28,902,036	29,769,097	30,662,170	31,582,035	32,529,496	33,505,381	34,510,542	35,545,859	36,612,234
Capital Expenditures (5%)	1,333,500	1,500,000	1,575,000	1,653,750	1,736,438	1,823,259	1,914,422	2,010,143	2,110,651	2,216,183	2,326,992	2,443,342	2,565,509	2,693,784	2,828,474	2,969,897
TOTAL EXPENSES	63,912,843	67,129,104	72,715,700	76,314,957	87,106,945	91,522,513	96,178,343	101,088,093	106,266,216	111,728,009	117,489,663	123,568,312	129,982,092	136,750,201	143,892,959	151,431,876
OUTSTANDING BOND DEBT SERVICE																
TRWD OUTSTANDING PRINCIPAL & INTEREST	71,742,914	71,169,384	63,521,162	64,446,229	64,996,969	64,410,912	64,750,821	62,498,919	60,055,852	57,912,989	57,917,489	57,917,489	57,917,489	57,917,489	57,917,489	57,917,489
DWU Contract Revenue Bonds	21,141,006	21,024,556	20,900,506	20,778,556	20,652,806	20,512,706	20,383,206	20,252,906	20,210,956	20,162,306	20,115,206	20,171,406	20,260,206	20,363,556	20,410,106	20,456,406
BOND PAYING AGENT FEES	3,850	3,350	3,350	3,350	3,350	3,350	3,350	3,350	3,350	3,350	3,350	3,350	3,350	3,350	3,350	3,350
TOTAL OUTSTANDING BOND DEBT SERVICE	92,887,770	92,197,290	84,425,018	85,228,135	85,653,125	84,926,968	85,137,377	82,755,175	80,270,158	78,078,645	78,036,045	78,092,245	78,181,045	78,284,395	78,330,945	78,377,245
PROPOSED BOND DEBT SERVICE																
2016 Issue for IPL-$300 mil	7,472,295	16,092,605	16,092,921	16,093,911	16,094,411	16,090,532	16,092,174	16,093,545	16,094,144	16,091,015	16,089,833	16,091,047	16,091,728	16,093,074	16,091,747	16,093,823
2016 other projects	972,641	2,378,644	2,382,769	2,380,313	2,381,275	2,380,513	2,378,025	2,378,669	2,382,156	2,378,488	2,382,519	2,379,106	2,378,250	2,379,663	2,378,200	2,378,719
2016 DWU Contract Revenue Bonds	3,468,208	7,549,781	7,551,752	7,550,954	7,553,356	7,549,465	7,553,861	7,551,317	7,551,871	7,550,425	7,553,406	7,550,587	7,553,321	7,552,037	7,553,101	7,551,457
2018 Issue for IPL-$195 mil and 20 mil for other projects	0	0	7,883,333	14,635,525	14,632,175	14,634,613	14,632,288	14,634,650	14,636,013	14,635,825	14,633,538	14,633,463	14,634,775	14,636,650	14,633,400	14,634,200
2018 DWU Contract Revenue Bonds	0	0	3,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000
BOND PAYING AGENT FEES	700	700	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050
TOTAL PROPOSED BOND DEBT SERVICE	11,913,844	26,021,730	36,911,825	45,661,753	45,662,267	45,656,173	45,657,398	45,659,231	45,665,234	45,656,803	45,660,346	45,655,253	45,659,124	45,662,474	45,657,498	45,659,249
SUBTOTAL DEBT SERVICE	104,801,614	118,219,020	121,336,843	130,889,888	131,315,392	130,583,141	130,794,775	128,414,406	125,935,392	123,735,448	123,696,391	123,747,498	123,840,169	123,946,869	123,988,443	124,036,494
TOTAL EXPENDITURES	168,714,457	185,348,124	194,052,543	207,204,845	218,422,337	222,105,654	226,973,118	229,502,499	232,201,608	235,463,457	241,186,054	247,315,810	253,822,261	260,697,070	267,881,402	275,468,370
OTHER INCOME																
WATER SALES NOT UNDER SYSTEM RATE	1,400,000	1,470,000	1,484,700	1,499,547	1,514,542	1,529,688	1,544,985	1,560,435	1,576,039	1,591,799	1,607,717	1,623,795	1,640,032	1,656,433	1,672,997	1,689,727
INTEREST EARNED	2,000,000	2,500,000	2,388,000	2,750,000	2,475,000	2,300,000	2,225,000	2,230,000	2,192,000	3,352,000	3,048,000	3,048,000	3,048,000	3,048,000	3,048,000	3,048,000
Sale of system capacity (DWU Contract Revenue Bonds)	24,609,214	28,574,337	31,452,258	33,329,510	33,206,162	33,062,171	32,937,067	32,804,223	32,762,827	32,712,731	32,668,612	32,721,993	32,813,527	32,915,593	32,963,207	33,007,863
Other Revenues	1,085,500	1,096,355	1,107,319	1,118,392	1,129,576	1,140,871	1,152,280	1,163,803	1,175,441	1,187,195	1,199,067	1,211,058	1,223,169	1,235,400	1,247,754	1,260,232
TOTAL OTHER INCOME	29,094,714	33,640,692	36,432,277	38,697,449	38,325,280	38,032,730	37,859,332	37,758,461	37,706,307	38,843,726	38,523,397	38,604,846	38,724,728	38,855,426	38,931,958	39,005,822
NET SYSTEM REQUIREMENTS	139,619,743	151,707,432	157,620,266	168,507,397	180,097,057	184,072,924	189,113,786	191,744,038	194,495,301	196,619,732	202,662,657	208,710,964	215,097,533	221,841,644	228,949,444	236,462,548

SYSTEM WATER RATES	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
5 yr customer demands projections then 1.00% after that (1st 2021)																
FORT WORTH (IN-DISTRICT)	48,600,000	48,850,000	49,100,000	49,350,000	49,650,000	50,146,500	50,647,965	51,154,445	51,665,989	52,182,649	52,704,475	53,231,520	53,763,835	54,301,474	54,844,489	55,392,933
FORT WORTH (OUT-DISTRICT)	20,844,000	20,950,000	21,050,000	21,150,000	21,250,000	21,462,500	21,677,125	21,893,896	22,112,835	22,333,964	22,557,303	22,782,876	23,010,705	23,240,812	23,473,220	23,707,952
ARLINGTON	19,201,194	20,370,546	20,370,546	20,370,546	20,370,546	20,574,251	20,779,994	20,987,794	21,197,672	21,409,649	21,623,745	21,839,983	22,058,382	22,278,966	22,501,756	22,726,773
TRINITY RIVER AUTHORITY	12,410,883	12,363,165	12,454,043	12,548,943	12,672,747	12,799,474	12,927,469	13,056,744	13,187,311	13,319,184	13,452,376	13,586,900	13,722,769	13,859,997	13,998,597	14,138,583
MANSFIELD	4,461,479	4,487,222	4,505,346	4,533,116	4,578,447	4,624,232	4,670,474	4,717,179	4,764,350	4,811,994	4,860,114	4,908,715	4,957,802	5,007,380	5,057,454	5,108,029
OTHER (IN-DISTRICT)	1,000,000	1,010,000	1,020,100	1,030,301	1,040,604	1,051,010	1,061,520	1,072,135	1,082,857	1,093,685	1,104,622	1,115,668	1,126,825	1,138,093	1,149,474	1,160,969
OTHER (OUT-DISTRICT)	10,000,000	10,100,000	10,201,000	10,303,010	10,406,040	10,510,101	10,615,202	10,721,354	10,828,567	10,936,853	11,046,221	11,156,683	11,268,250	11,380,933	11,494,742	11,609,690
TOTAL	116,517,556	118,130,933	118,701,035	119,285,916	119,968,384	121,168,068	122,379,749	123,603,546	124,839,582	126,087,978	127,348,857	128,622,346	129,908,569	131,207,655	132,519,732	133,844,929
PROJECTED SYSTEM WATER RATES ($/1000 GAL.)																
FORT WORTH (IN-DISTRICT)	1.19225	1.27972	1.32488	1.41116	1.50120	1.51915	1.54530	1.55128	1.55796	1.55939	1.59140	1.62266	1.65576	1.69077	1.72766	1.76669
FORT WORTH (OUT-DISTRICT)	1.20425	1.28872	1.33088	1.41416	1.50120	1.51915	1.54530	1.55128	1.55796	1.55939	1.59140	1.62266	1.65576	1.69077	1.72766	1.76669
ARLINGTON	1.19900	1.28472	1.32813	1.41266	1.50120	1.51915	1.54530	1.55128	1.55796	1.55939	1.59140	1.62266	1.65576	1.69077	1.72766	1.76669
TRINITY RIVER AUTHORITY	1.20425	1.28872	1.33088	1.41416	1.50120	1.51915	1.54530	1.55128	1.55796	1.55939	1.59140	1.62266	1.65576	1.69077	1.72766	1.76669
MANSFIELD	1.20425	1.28872	1.33088	1.41416	1.50120	1.51915	1.54530	1.55128	1.55796	1.55939	1.59140	1.62266	1.65576	1.69077	1.72766	1.76669
OTHER (IN-DISTRICT)	1.19225	1.27972	1.32488	1.41116	1.50120	1.51915	1.54530	1.55128	1.55796	1.55939	1.59140	1.62266	1.65576	1.69077	1.72766	1.76669
OTHER (OUT-DISTRICT)	1.20425	1.28872	1.33088	1.41416	1.50120	1.51915	1.54530	1.55128	1.55796	1.55939	1.59140	1.62266	1.65576	1.69077	1.72766	1.76669
PROJECTED SYSTEM REVENUE: ($)																
FORT WORTH (IN-DISTRICT)	57,943,134	62,514,305	65,051,679	69,640,631	74,534,794	76,180,243	78,266,450	79,355,003	80,493,638	81,372,853	83,873,772	86,376,919	89,020,058	91,811,169	94,752,796	97,862,163
FORT WORTH (OUT-DISTRICT)	25,101,294	26,998,677	28,015,055	29,909,435	31,900,592	32,604,837	33,497,725	33,963,622	34,450,953	34,827,253	35,897,637	36,968,973	38,100,226	39,294,811	40,553,815	41,884,611
ARLINGTON	23,022,146	26,170,441	27,054,763	28,776,608	30,580,352	31,255,451	32,111,386	32,558,001	33,025,163	33,385,890	34,411,975	35,438,973	36,523,408	37,668,553	38,875,452	40,151,172
TRINITY RIVER AUTHORITY	14,945,751	15,932,654	16,574,855	17,746,184	19,024,383	19,444,370	19,976,856	20,254,700	20,545,327	20,769,740	21,408,078	22,046,986	22,721,625	23,434,033	24,184,858	24,978,498
MANSFIELD	5,372,716	5,782,771	5,996,081	6,410,541	6,873,185	7,024,919	7,217,297	7,317,678	7,422,676	7,503,752	7,734,373	7,965,200	8,208,935	8,466,316	8,737,576	9,024,305
OTHER (IN-DISTRICT)	1,192,246	1,292,517	1,351,512	1,453,917	1,562,159	1,596,646	1,640,370	1,663,185	1,687,049	1,705,477	1,757,893	1,810,356	1,865,753	1,924,251	1,985,904	2,051,073
OTHER (OUT-DISTRICT)	12,042,456	13,016,068	13,576,322	14,570,081	15,621,592	15,966,458	16,403,702	16,631,850	16,870,494	17,054,767	17,578,929	18,103,559	18,657,529	19,242,512	19,859,041	20,510,727
TOTAL	139,619,743	151,707,432	157,620,266	168,507,397	180,097,057	184,072,924	189,113,786	191,744,038	194,495,301	196,619,732	202,662,657	208,710,964	215,097,533	221,841,644	228,949,444	236,462,548

	PROJECTED 2032	PROJECTED 2033	PROJECTED 2034	PROJECTED 2035	PROJECTED 2036	PROJECTED 2037	PROJECTED 2038	PROJECTED 2039	PROJECTED 2040	PROJECTED 2041	PROJECTED 2042	PROJECTED 2043	PROJECTED 2044	PROJECTED 2045	PROJECTED 2046
SYSTEM OPERATIONS															
Operations and Maintenance	118,560,729	125,674,373	133,214,835	141,207,725	149,680,189	158,661,000	168,180,660	178,271,500	188,967,790	200,305,857	212,324,209	225,063,661	238,567,481	252,881,530	268,054,422
Pumping Power (53)	37,710,601	38,841,919	40,007,177	41,207,392	42,443,614	43,716,922	45,028,430	46,379,283	47,770,662	49,203,781	50,679,895	52,200,292	53,766,300	55,379,289	57,040,668
Capital Expenditures (5%)	3,118,392	3,274,312	3,438,027	3,609,929	3,790,425	3,979,947	4,178,944	4,387,891	4,607,286	4,837,650	5,079,532	5,333,509	5,600,184	5,880,194	6,174,203
TOTAL EXPENSES	159,389,723	167,790,604	176,660,040	186,025,047	195,914,228	206,357,869	217,388,034	229,038,674	241,345,737	254,347,289	268,083,636	282,597,462	297,933,966	314,141,013	331,269,293
OUTSTANDING BOND DEBT SERVICE															
TRWD OUTSTANDING PRINCIPAL & INTEREST	57,917,489	57,917,489	57,917,489	57,917,489	57,917,489	57,917,489	57,917,489	57,917,489	57,917,489	57,917,489	57,917,489	57,917,489	57,917,489	57,917,489	57,917,489
DWU Contract Revenue Bonds	20,500,812	20,495,862	20,556,062	20,607,562	20,664,412	20,725,062	20,787,862	20,776,212	20,761,512	20,747,312	20,736,962	13,053,562	13,057,312	0	0
BOND PAYING AGENT FEES	3,350	3,350	3,350	3,350	3,350	3,350	3,350	3,350	3,350	3,350	3,350	3,350	3,350	3,350	3,350
TOTAL OUTSTANDING BOND DEBT SERVICE	78,421,651	78,416,701	78,476,901	78,528,401	78,585,251	78,645,901	78,708,701	78,697,051	78,682,351	78,668,151	78,657,801	70,974,401	70,978,151	57,920,839	57,920,839
PROPOSED BOND DEBT SERVICE															
2016 Issue for IPL-$300 mil	16,094,425	16,093,884	16,092,361	16,094,431	16,089,757	16,094,381	16,094,270	16,093,986	16,093,002	16,090,950	16,091,867	16,089,626	16,093,514	16,092,814	0
2016 other projects	2,380,931	2,379,694	2,379,863	2,381,150	2,378,413	2,381,363	2,379,713	2,378,319	2,381,750	2,379,719	2,381,938	2,378,119	2,377,975	2,380,931	2,381,556
2016 DWU Contract Revenue Bonds	7,552,404	7,550,755	7,551,985	7,550,869	7,552,208	7,551,095	7,553,541	7,554,196	7,552,888	7,549,441	7,554,181	7,550,749	7,549,145	7,549,014	
2018 Issue for IPL-$195 mil and 20 mil for other projects	14,633,088	14,634,100	14,636,138	14,633,238	14,634,300	14,633,088	14,633,363	14,633,750	14,632,875	14,634,225	14,636,150	14,637,000	14,635,125	14,633,738	14,635,775
2018 DWU Contract Revenue Bonds	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000
BOND PAYING AGENT FEES	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050
TOTAL PROPOSED BOND DEBT SERVICE	45,661,898	45,659,483	45,661,397	45,660,738	45,655,728	45,660,977	45,661,937	45,661,301	45,661,565	45,655,385	45,665,186	45,656,544	45,656,809	45,657,547	22,018,381
SUBTOTAL DEBT SERVICE	124,083,549	124,076,184	124,138,298	124,189,139	124,240,979	124,306,878	124,370,638	124,358,352	124,343,916	124,323,536	124,322,987	116,630,945	116,634,960	103,578,386	79,939,220
TOTAL EXPENDITURES	283,473,272	291,866,788	300,798,338	310,214,186	320,155,207	330,664,747	341,758,672	353,397,026	365,689,653	378,670,825	392,406,623	399,228,407	414,568,926	417,719,399	411,208,513
OTHER INCOME															
WATER SALES NOT UNDER SYSTEM RATE	1,706,624	1,723,691	1,740,928	1,758,337	1,775,920	1,793,679	1,811,616	1,829,732	1,848,030	1,866,510	1,885,175	1,904,027	1,923,067	1,942,298	1,961,721
INTEREST EARNED	3,048,000	3,048,000	3,048,000	3,048,000	3,048,000	3,048,000	3,048,000	3,048,000	3,048,000	3,048,000	3,048,000	3,048,000	3,048,000	3,048,000	3,048,000
Sale of system capacity (DWU Contract Revenue Bonds)	33,053,216	33,046,617	33,108,047	33,158,431	33,216,620	33,276,157	33,341,403	33,330,408	33,314,400	33,296,753	33,291,143	25,604,311	25,606,457	12,549,014	5,000,000
Other Revenues	1,272,834	1,285,562	1,298,418	1,311,402	1,324,516	1,337,761	1,351,139	1,364,650	1,378,297	1,392,080	1,406,001	1,420,061	1,434,261	1,448,604	1,463,090
TOTAL OTHER INCOME	39,080,674	39,103,870	39,195,393	39,276,170	39,365,056	39,455,598	39,552,158	39,572,791	39,588,727	39,603,343	39,630,319	31,976,399	32,011,785	18,987,916	11,472,811
NET SYSTEM REQUIREMENTS	244,392,597	252,762,918	261,602,945	270,938,016	280,790,151	291,209,150	302,206,514	313,824,235	326,100,927	339,067,482	352,776,304	367,252,009	382,557,141	398,731,483	399,735,702

SYSTEM WATER RATES	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046
PROJECTED WATER USE (1000 GAL.)															
5 yr customer demands projections then 1.00% after that (1s															
FORT WORTH (IN-DISTRICT)	55,946,863	56,506,331	57,071,395	57,642,109	58,218,530	58,800,715	59,388,722	59,982,609	60,582,435	61,188,260	61,800,142	62,418,144	63,042,325	63,672,749	64,309,476
FORT WORTH (OUT-DISTRICT)	23,945,032	24,184,482	24,426,327	24,670,590	24,917,296	25,166,469	25,418,134	25,672,315	25,929,038	26,188,329	26,450,212	26,714,714	26,981,861	27,251,680	27,524,197
ARLINGTON	22,954,041	23,183,582	23,415,417	23,649,572	23,886,067	24,124,928	24,366,177	24,609,839	24,855,937	25,104,497	25,355,542	25,609,097	25,865,188	26,123,840	26,385,078
TRINITY RIVER AUTHORITY	14,279,969	14,422,768	14,566,996	14,712,666	14,859,793	15,008,390	15,158,474	15,310,059	15,463,160	15,617,791	15,773,969	15,931,709	16,091,026	16,251,936	16,414,456
MANSFIELD	5,159,109	5,210,700	5,262,807	5,315,435	5,368,589	5,422,275	5,476,498	5,531,263	5,586,576	5,642,441	5,698,866	5,755,854	5,813,413	5,871,547	5,930,263
OTHER (IN-DISTRICT)	1,172,579	1,184,304	1,196,147	1,208,109	1,220,190	1,232,392	1,244,716	1,257,163	1,269,735	1,282,432	1,295,256	1,308,209	1,321,291	1,334,504	1,347,849
OTHER (OUT-DISTRICT)	11,725,786	11,843,044	11,961,475	12,081,090	12,201,900	12,323,919	12,447,159	12,571,630	12,697,346	12,824,320	12,952,563	13,082,089	13,212,910	13,345,039	13,478,489
TOTAL	135,183,378	136,535,212	137,900,564	139,279,570	140,672,365	142,079,089	143,499,880	144,934,879	146,384,228	147,848,070	149,326,551	150,819,816	152,328,014	153,851,294	155,389,807
PROJECTED SYSTEM WATER RATES ($/1000 GAL.)															
FORT WORTH (IN-DISTRICT)	1.80786	1.85127	1.89704	1.94528	1.99606	2.04963	2.10597	2.16528	2.22771	2.29335	2.36245	2.43504	2.51140	2.59167	2.57247
FORT WORTH (OUT-DISTRICT)	1.80786	1.85127	1.89704	1.94528	1.99606	2.04963	2.10597	2.16528	2.22771	2.29335	2.36245	2.43504	2.51140	2.59167	2.57247
ARLINGTON	1.80786	1.85127	1.89704	1.94528	1.99606	2.04963	2.10597	2.16528	2.22771	2.29335	2.36245	2.43504	2.51140	2.59167	2.57247
TRINITY RIVER AUTHORITY	1.80786	1.85127	1.89704	1.94528	1.99606	2.04963	2.10597	2.16528	2.22771	2.29335	2.36245	2.43504	2.51140	2.59167	2.57247
MANSFIELD	1.80786	1.85127	1.89704	1.94528	1.99606	2.04963	2.10597	2.16528	2.22771	2.29335	2.36245	2.43504	2.51140	2.59167	2.57247
OTHER (IN-DISTRICT)	1.80786	1.85127	1.89704	1.94528	1.99606	2.04963	2.10597	2.16528	2.22771	2.29335	2.36245	2.43504	2.51140	2.59167	2.57247
OTHER (OUT-DISTRICT)	1.80786	1.85127	1.89704	1.94528	1.99606	2.04963	2.10597	2.16528	2.22771	2.29335	2.36245	2.43504	2.51140	2.59167	2.57247
PROJECTED SYSTEM REVENUE: ($)															
FORT WORTH (IN-DISTRICT)	101,144,085	104,608,218	108,266,743	112,130,146	116,207,541	120,519,538	125,070,897	129,878,996	134,959,815	140,326,142	145,999,662	151,990,563	158,324,730	165,018,628	165,434,233
FORT WORTH (OUT-DISTRICT)	43,289,261	44,771,896	46,337,730	47,991,251	49,736,360	51,581,877	53,529,840	55,587,687	57,762,257	60,059,023	62,487,267	65,051,349	67,762,347	70,627,308	70,805,185
ARLINGTON	41,497,689	42,918,963	44,419,993	46,005,082	47,677,967	49,447,106	51,314,450	53,287,131	55,371,705	57,573,416	59,901,165	62,359,129	64,957,929	67,704,321	67,874,837
TRINITY RIVER AUTHORITY	25,816,181	26,700,372	27,634,180	28,620,281	29,661,002	30,761,604	31,923,300	33,150,527	34,447,363	35,817,073	37,265,192	38,794,319	40,411,062	42,119,624	42,225,704
MANSFIELD	9,326,946	9,646,389	9,983,758	10,340,019	10,716,014	11,113,642	11,533,343	11,976,719	12,445,244	12,940,097	13,463,278	14,015,725	14,599,827	15,217,101	15,255,426
OTHER (IN-DISTRICT)	2,119,858	2,192,462	2,269,140	2,350,112	2,435,570	2,525,944	2,621,335	2,722,107	2,828,595	2,941,066	3,059,977	3,185,539	3,318,295	3,458,591	3,467,302
OTHER (OUT-DISTRICT)	21,198,578	21,924,619	22,691,401	23,501,124	24,355,697	25,259,439	26,213,349	27,221,068	28,285,947	29,410,664	30,599,765	31,855,385	33,182,950	34,585,911	34,673,016
TOTAL	244,392,597	252,762,918	261,602,945	270,938,016	280,790,151	291,209,150	302,206,514	313,824,235	326,100,927	339,067,482	352,776,304	367,252,009	382,557,141	398,731,483	399,735,702

TARRANT REGIONAL WATER DISTRICT - Part C #46
Five year comparative system Operating Statement
STATEMENT OF REVENUES, EXPENSES, AND CHANGES IN NET POSITION—ENTERPRISE FUND

	UnAudited - 2nd Quarter	Audited				
	2015	2014	2013	2012	2011	2010
OPERATING REVENUES:						
Sale of water	$ 63,518,545	$ 121,710,988	$ 112,139,871	$ 98,844,939	$ 90,310,650	$ 79,465,525
Sale of system capacity	10,610,903	14,072,987	7,903,394	-	-	-
Land lease rentals	26,710	88,640	85,681	76,624	79,586	78,480
Sale of Power	9,912	-	-	-	-	-
Other	755,945	942,094	1,081,368	594,205	1,439,863	940,119
Total operating revenues	74,922,015	136,814,709	121,210,314	99,515,768	91,830,099	80,484,124
OPERATING EXPENSES:						
General and administrative	8,600,239	27,693,314	20,932,405	17,361,268	14,737,095	12,375,073
Personnel services	5,597,063	11,136,074	10,235,724	9,690,663	10,501,881	10,525,135
Utilities	11,094,862	29,499,922	23,328,536	17,996,090	15,108,701	10,173,954
Depreciation and amortization	-	16,428,450	16,573,425	16,656,082	16,174,207	15,663,973
Pension plan contribution	616,586	1,223,685	1,156,824	1,078,990	1,093,831	673,986
Total operating expenses	25,908,750	85,981,445	72,226,914	62,783,093	57,615,715	49,412,121
OPERATING INCOME	49,013,265	50,833,264	48,983,400	36,732,675	34,214,384	31,072,003
NONOPERATING INCOME (EXPENSE):						
Investment income	2,321,258	1,598,019	262,520	2,183,834	1,873,044	2,969,407
Interest expense	(30,019,730)	(18,920,099)	(14,938,583)	(19,238,227)	(19,140,654)	(19,714,313)
Gain on disposal of capital assets	27,243	43,508	48,310	56,343	72,296	67,958
Total nonoperating income (expense)	(27,671,229)	(17,278,572)	(14,627,753)	(16,998,050)	(17,195,314)	(16,676,948)
NET INCOME	21,342,036	33,554,692	34,355,647	19,734,625	17,019,070	14,395,055
NET POSITION----Beginning of year	371,867,216	338,312,524	312,220,780	292,486,155	275,372,007	260,976,952
Change in accounting principle due to implementation of GASB 65	-	-	(8,263,903)	-	-	-
Net Position ---Beginning of year adjusted	371,867,216	338,312,524	303,956,877	292,486,155	275,372,007	260,976,952
NET POSITION—End of year	$ 393,209,252	$ 371,867,216	$ 338,312,524	$ 312,220,780	$ 292,391,077	$ 275,372,007

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Part C #46

Tarrant Regional Water District

Report to Management for the
Year Ended September 30, 2014

Deloitte.

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January 9, 2015

Board of Directors of Tarrant Regional Water District
Fort Worth, Texas

The Management of Tarrant Regional Water District
Fort Worth, Texas

Dear Members of the Board of Directors and Management:

In planning and performing our audit of the financial statements of Tarrant Regional Water District (the "District") as of and for the year ended September 30, 2014 (on which we have issued our report dated January 9, 2015), in accordance with auditing standards generally accepted in the United States of America, we considered the District's internal control over financial reporting as a basis for designing audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on the effectiveness of the District's internal control over financial reporting. Accordingly, we do not express an opinion on the effectiveness of the District's internal control over financial reporting.

Our consideration of internal control over financial reporting was for the limited purpose described in the preceding paragraph and was not designed to identify all deficiencies in internal control over financial reporting that might be significant deficiencies or material weaknesses and therefore, material weaknesses or significant deficiencies may exist that were not identified. We did not identify any deficiencies in internal control over financial reporting that we consider to be material weaknesses.

We have identified, and included in the attached Appendix, other matters as of September 30, 2014 that we wish to bring to your attention.

The definitions of a deficiency and a material weakness are also set forth in the attached Appendix.

A description of the responsibility of management for establishing and maintaining internal control over financial reporting and of the objectives of and inherent limitations of internal control over financial reporting, is set forth in the attached Appendix and should be read in conjunction with this report.

This report is intended solely for the information and use of management, the Board of Directors, and others within the organization and is not intended to be, and should not be, used by anyone other than these specified parties.

Yours truly,

Deloitte & Touche LLP

APPENDIX

SECTION I — OTHER MATTERS

Other matters related to new pronouncements that we wish to bring to your attention are as follows:

GASB Statement No. 68: *Accounting and Financial Reporting for Pensions* was issued in June 2012 and establishes accounting and financial reporting requirements related to pensions for governments whose employees are provided with pensions through pension plans, as well as for nonemployer governments that have a legal obligation to contribute to those plans. This statement requires the recognition of the entire net pension liability and a more comprehensive measure of pension expense, along with additional required footnote disclosures. This standard becomes effective for the District in fiscal year 2015.

GASB Statement No. 69: *Government Combinations and Disposals of Government Operations* was issued in January 2013 and establishes accounting and financial reporting standards for government combinations and disposals of government operations. This statement distinguishes between government mergers and acquisitions and provides guidance on the appropriate accounting treatment of each. This Statement also provides guidance for transfers of operations that do not constitute entire legally separate entities and in which no significant consideration is exchanged. GASB 69 becomes effective for the District in fiscal year 2015, and should be applied on a prospective basis.

GASB Statement No. 71: *Pension Transition for Contributions Made Subsequent to the Measurement Date, an amendment of GASB Statement No. 68* was issued in November 2013 and addresses an issue relates to amounts associated with contributions, if any, made by a state or local government employer or nonemployer contributing entity to a defined benefit pension plan after the measurement date of the government's beginning net pension liability. This standard becomes effective for the District in fiscal year 2015.

SECTION II — DEFINITIONS

The definitions of a deficiency and a material weakness are as follows:

A *deficiency* exists when the design or operation of a control does not allow management or employees, in the normal course of performing their assigned functions, to prevent, or detect and correct misstatements on a timely basis.

A *material weakness* is a deficiency, or a combination of deficiencies, in internal control over financial reporting, such that there is a reasonable possibility that a material misstatement of the entity's financial statements will not be prevented, or detected and corrected on a timely basis.

SECTION III - MANAGEMENT'S RESPONSIBILITY FOR, AND THE OBJECTIVES AND LIMITATIONS OF, INTERNAL CONTROL OVER FINANCIAL REPORTING

The following comments concerning management's responsibility for internal control over financial reporting and the objectives and inherent limitations of internal control over financial reporting are adapted from auditing standards generally accepted in the United States of America.

Management's Responsibility

The District's management is responsible for the overall accuracy of the financial statements and their conformity with generally accepted accounting principles. In this regard, management is also responsible for establishing and maintaining effective internal control over financial reporting.

Objectives of Internal Control over Financial Reporting

Internal control over financial reporting is a process effected by those charged with governance, management, and other personnel and designed to provide reasonable assurance about the achievement of the entity's objectives with regard to reliability of financial reporting, effectiveness and efficiency of operations, and compliance with applicable laws and regulations. Internal control over the safeguarding of assets against unauthorized acquisition, use, or disposition may include controls related to financial reporting and operations objectives. Generally, controls that are relevant to an audit of financial statements are those that pertain to the entity's objective of reliable financial reporting (i.e., the preparation of reliable financial statements that are fairly presented in conformity with generally accepted accounting principles).

Inherent Limitations of Internal Control over Financial Reporting

Because of the inherent limitations of internal control over financial reporting, including the possibility of collusion or improper management override of controls, material misstatements due to error or fraud may not be prevented or detected and corrected on a timely basis. Also, projections of any evaluation of the effectiveness of the internal control over financial reporting to future periods are subject to the risk that the controls may become inadequate because of changes in conditions, or that the degree of compliance with the policies or procedures may deteriorate.

* * * * *

TARRANT REGIONAL WATER DISTRICT

FORT WORTH, TEXAS

Annual Financial Report
As of and for the year ended
September 30, 2014

Annual Financial Report
As of and for the Year Ended
September 30, 2014

Board of Directors

Victor W. Henderson, President

Jack R. Stevens, Vice-President

Martha V. Leonard, Secretary

James W. Lane, Secretary Pro-Tem

Mary Kelleher, Director

General Manager

James M. Oliver

Deputy General Manager

R. Alan Thomas

Director of Finance

Sandra Newby

TARRANT REGIONAL WATER DISTRICT – FORT WORTH, TEXAS

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INDEPENDENT AUDITORS' REPORT

Members of the Board of Directors
Tarrant Regional Water District
Fort Worth, Texas

Report on the Financial Statements

We have audited the accompanying financial statements of the governmental activities, business-type activities, discretely presented component unit, and the major fund of Tarrant Regional Water District (the "District"), as of and for the year ended September 30, 2014, and the related notes to the financial statements, which collectively comprise the District's basic financial statements as listed in the table of contents.

Management's Responsibility for the Financial Statements

Management is responsible for the preparation and fair presentation of these financial statements in accordance with accounting principles generally accepted in the United States of America; this includes the design, implementation, and maintenance of internal control relevant to the preparation and fair presentation of financial statements that are free from material misstatement, whether due to fraud or error.

Auditor's Responsibility

Our responsibility is to express opinions on these financial statements based on our audit. We conducted our audit in accordance with auditing standards generally accepted in the United States of America. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether the financial statements are free from material misstatement.

An audit involves performing procedures to obtain audit evidence about the amounts and disclosures in the financial statements. The procedures selected depend on the auditor's judgment, including the assessment of the risks of material misstatement of the financial statements, whether due to fraud or error. In making those risk assessments, the auditor considers internal control relevant to the entity's preparation and fair presentation of the financial statements in order to design audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on the effectiveness of the entity's internal control. Accordingly, we express no such opinion. An audit also includes evaluating the appropriateness of accounting policies used and the reasonableness of significant accounting estimates made by management, as well as evaluating the overall presentation of the financial statements.

We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our audit opinions.

Opinions

In our opinion, the financial statements referred to above present fairly, in all material respects, the respective financial position of the governmental activities, the business-type activities, the discretely presented component unit, and the major fund of Tarrant Regional Water District as of September 30, 2014, and the respective changes in financial position and, where applicable, cash flows thereof for the year then ended in accordance with accounting principles generally accepted in the United States of America.

Other Matters

Required Supplementary Information

Accounting principles generally accepted in the United States of America require that management's discussion and analysis, General Fund budgetary comparison information, and Other Post-Employment Benefits Schedule of Funding Progress and Employer Contributions be presented to supplement the basic financial statements. Such information, although not a part of the basic financial statements, is required by the Governmental Accounting Standards Board who considers it to be an essential part of financial reporting for placing the basic financial statements in an appropriate operational, economic, or historical context. We have applied certain limited procedures to the required supplementary information in accordance with auditing standards generally accepted in the United States of America, which consisted of inquiries of management about the methods of preparing the information and comparing the information for consistency with management's responses to our inquiries, the basic financial statements, and other knowledge we obtained during our audit of the basic financial statements. We do not express an opinion or provide any assurance on the information because the limited procedures do not provide us with sufficient evidence to express an opinion or provide any assurance.

Other Information

Our audit was conducted for the purpose of forming opinions on the financial statements that collectively comprise the District's basic financial statements. The accompanying Required Texas Commission on Environmental Quality Schedules and Statistical Section Schedules are presented for purposes of additional analysis and are not a required part of the basic financial statements.

The required Texas Commission on Environmental Quality schedules and Statistical Section Schedules have not been subjected to the auditing procedures applied in the audit of the basic financial statements, and accordingly, we do not express an opinion or provide any assurance on them.

Deloitte & Touche LLP

January 9, 2015

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TARRANT REGIONAL WATER DISTRICT

MANAGEMENT'S DISCUSSION AND ANALYSIS
FOR THE YEAR ENDED SEPTEMBER 30, 2014 (UNAUDITED)

This section of Tarrant Regional Water District's (the "District") annual financial report presents our discussion and analysis of the District's financial performance during the fiscal year ended September 30, 2014. Please read this analysis in conjunction with the District's audited financial statements, which follow this discussion.

FINANCIAL HIGHLIGHTS

NET POSITION

The assets and deferred outflows of the District exceeded its liabilities and deferred inflows at the close of the most recent fiscal year by $831.0 million (*net position*). Of this amount, $152.0 million (unrestricted net position) may be used to meet the District's ongoing obligations to citizens and creditors.

At the end of the current fiscal year: Business-Type Activities total net position increased by $33.6 million mainly due to the increase in net investment in capital assets, for design and construction related to the 2009, 2010, 2012, and 2014 bond issues. Governmental activities total net position increased by $49.8 million mainly due to the continuation of several large capital projects such as Twin Points and the Trinity River Vision Project.

OVERVIEW OF LARGE PROJECTS

The District engaged in multiple large, water supply related, construction projects funded through bond issues, as well as the Trinity River Vision Project which is funded through oil and gas and Tax Increment Reinvestment Zone #9 revenues and other smaller construction related projects. These projects are discussed on the following pages.

ENTERPRISE FUND-WATER SUPPLY PROJECTS

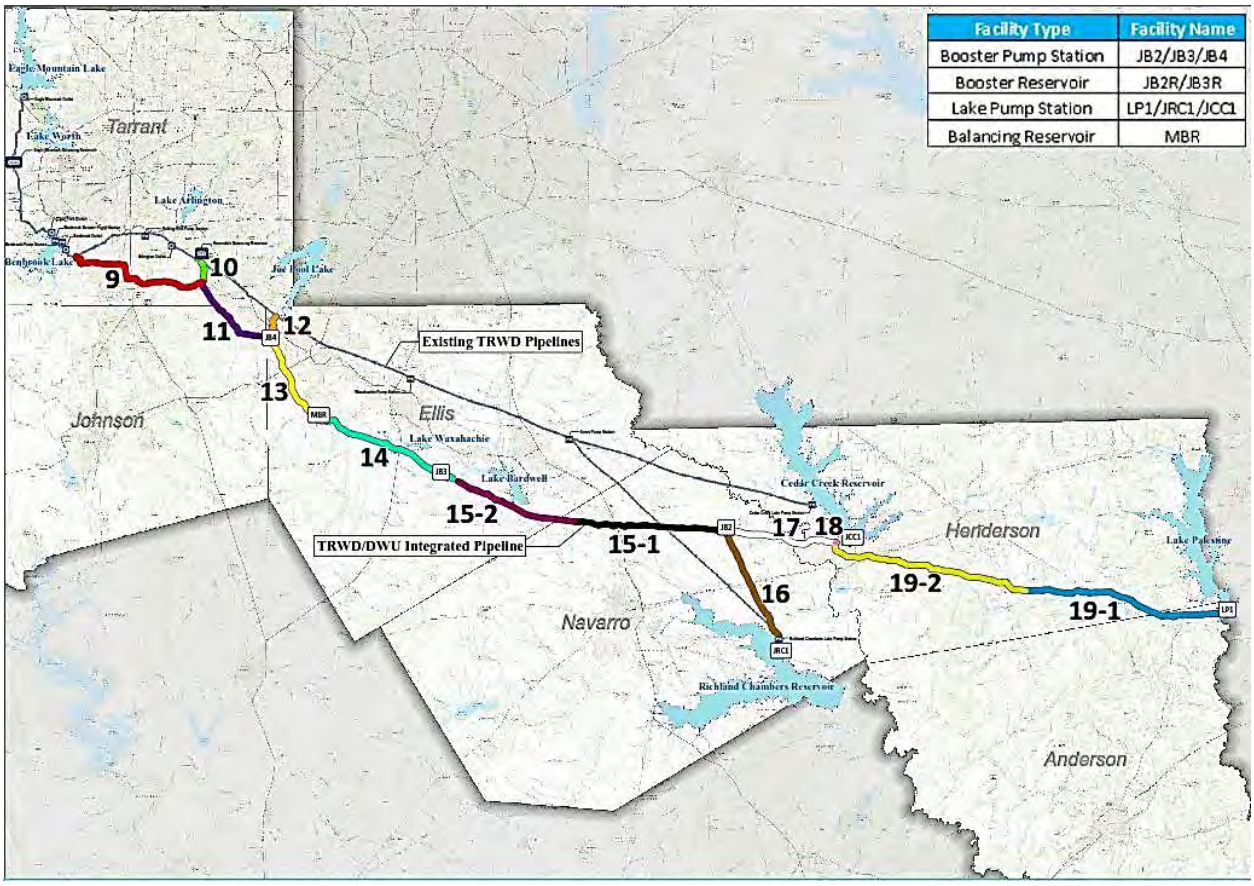
Third East Texas Pipeline/Integrated Pipeline

The District and the City of Dallas Water Utilities (DWU) have partnered to finance, plan, design, construct, and operate the Integrated Pipeline (IPL) Project. The IPL Project is an integrated water delivery transmission system connecting Lake Palestine to Lake Benbrook with connections to Cedar Creek and Richland-Chambers Reservoirs that integrates the District's existing pipeline system and creates flexibility in delivery as well as quick response to fluctuating customer water demands. The IPL Project consists of 150 miles of pipeline, three new lake pump stations, and three new booster pump stations, delivering a required capacity of 350 million gallons (MGD) of raw water per day to North Central Texas. The District and DWU currently serve over 4.1 million residents and the IPL Project will allow these agencies to continue supporting regional community and economic growth. On-going studies, additional design, and construction are being paid for with the TRWD 2009, 2010, 2012 and 2014, DWU 2012 and 2014 bond issues, as well as future bond issues. The estimated total cost to the District for this project is approximately $1.4 billion and Dallas Water Utilities is approximately $938 million. As of September 30, 2014, $350 million in cost has been incurred for the IPL Project.

Progress for this project is as follows:

- Final design for the core portion of the project is at 90% complete on the pipeline, 95% complete on the pump stations, and 100% complete on the reservoirs
- The project has acquired 243 of the 522 required parcels as of September 2014
- The Richland Chambers line lowering was completed in May 2014
- Construction on the first section of the pipeline, Section 15, was bid and construction began in Spring of 2014. Of this $92.9 million contract, $48.1 million of costs were incurred in FY14.
- Various valves (butterfly, gate, and multi-orifice valves) to control water and enable construction have been bid out during 2014, and are expected to begin installation in January 2015.
- The construction of the joint booster pump station JB3 was bid and a contract signed for $11.4 million. Construction began in Summer of 2014 and $662 thousand of costs were incurred in FY14.
- Pipeline section 12, 13, and the Midlothian Balancing Reservoir were bid and a contract signed for $149.6 million in FY14.

On the following page is a general overview depicting the District's existing East Texas Pipeline and the new IPL pipeline to the south of the existing line:



Picture 1- Overview of Integrated Pipeline

Richland-Chambers Wetlands

The George W. Shannon Wetlands at Richland-Chambers Reservoir is located southeast of the reservoir and in northern Freestone and southern Navarro Counties, and are used to polish the Trinity River water to a quality such that no adverse impacts will be seen as it is introduced in the reservoir. The last phase of construction brought the project to its ultimate size of just over 2,000 acres.

The final expansion started construction during the winter of 2011. It included additional acres of wetlands, various canals, and other structures such as sediment basins and flexible base pavement for driving equipment out onto the property. The Wetlands became operational in fall of 2014.

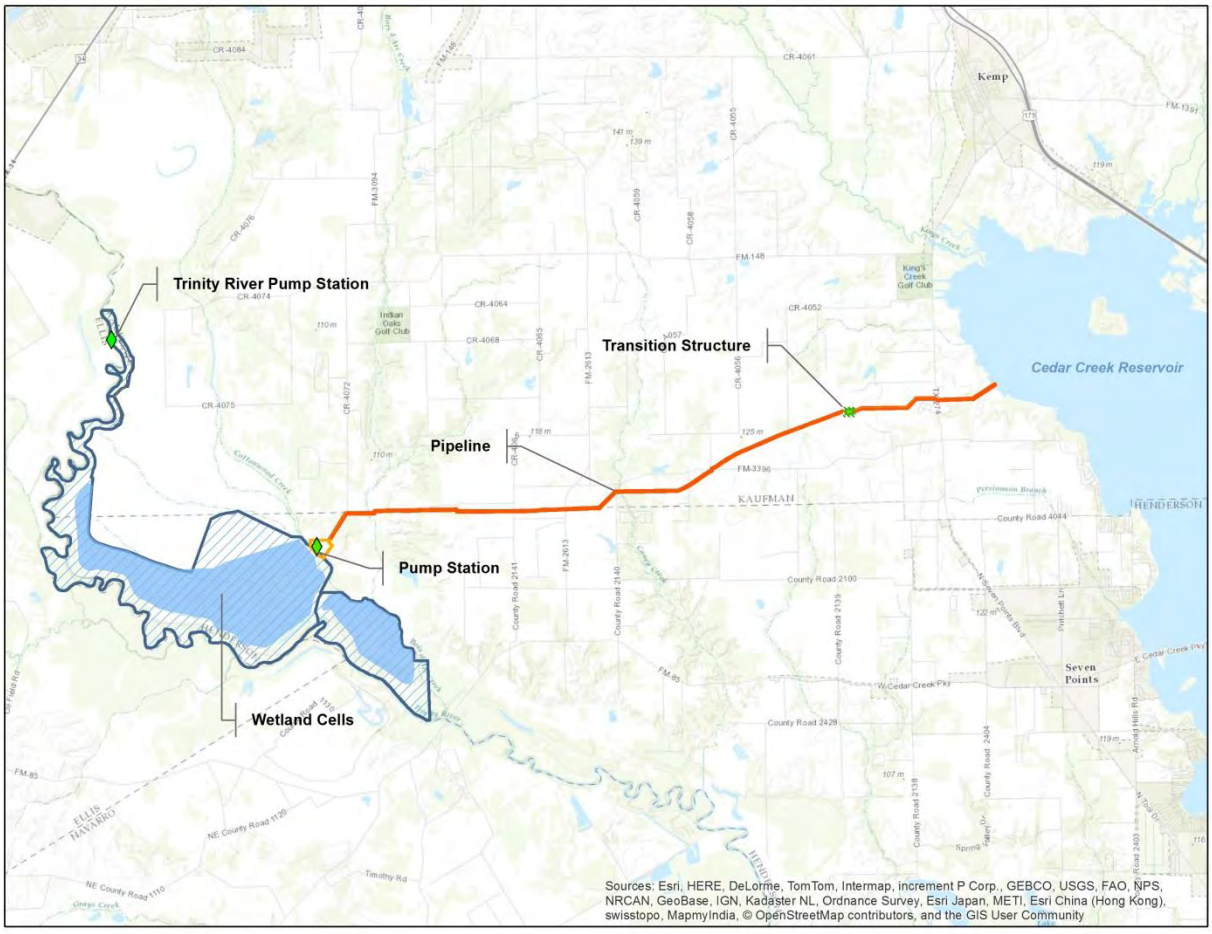
A total of $72.5 million was spent on the full footprint of the Richland-Chambers Wetlands Project. These funds were paid for with multiple bond issues (1999, 2002, 2006, 2008A, and 2010).

A picture showing the completed George W. Shannon Wetlands is shown below:

Picture 2 – Completed George W. Shannon Wetlands

Cedar Creek Wetlands

The proposed wetlands at Cedar Creek Reservoir have completed preliminary design. The area of interest of the project location is in northern Kaufman County to the west of the reservoir. The facility is planned to be constructed in one effort which will include the construction of a pump station at the Trinity River, 2,000 acres of wetland cells and associated structures, a final pump station, and its associated pipeline to transport 80 million gallons of treated water per day from the wetlands into the reservoir. Preliminary design efforts were funded with the 2008B bond issue and to date $4.3 million has been spent on design. Land acquisition for the Cedar Creek Wetlands was funded with the 2010 bond issue. In January 2014 the District began securing 4,192 acres for the wetlands project site in Henderson and Kaufman Counties. To date, $15.2 million has been spent on land acquisition. The acquisition of the facilities sites as well as the pipeline right of way should be completed in 2015. A drawing of the proposed Cedar Creek Wetlands is shown below:



Picture 3 - Cedar Creek Wetlands

Line J Section 1C Kennedale Balancing Reservoir Expansion

This project will install an additional pipeline from the Kennedale Balancing Reservoir (KBR) to the Arlington outlet and a third cell at the Kennedale Balancing Reservoir. These components will improve operations, increase reliability and add redundancy to the system. The proposed expansion will provide an additional 150 million gallons of storage by adding a third cell to KBR. The construction of this pipeline was completed in September 2014 at a cost of $24.1 million. The construction of the third cell is expected to start in 2020. Below is a photograph of workers lowering an 84" tee into place on Line J:

Picture 4 – Lowering tee into place on Kennedale Line J Section 1C

GENERAL FUND PROJECTS

Trinity River Vision Project

The United States Army Corps of Engineers (USACE) and the District have been partnering to address water resources needs associated with the Trinity River for more than fifty years. After severe flooding in the late 1940s Congress authorized the Fort Worth Floodway Program which allowed the USACE to construct a flood protection system on the Trinity River in Fort Worth. This created the Fort Worth Floodway as we know it today. The District is the local sponsor of the Fort Worth Floodway and responsible for operation and maintenance of thirty miles of river and trail system. In the mid-1980s, the USACE, in cooperation with the District and other regional sponsors, began a series of Trinity River planning and flood plan management initiatives basin-wide, which ultimately led to the Trinity River Vision Project (TRV).

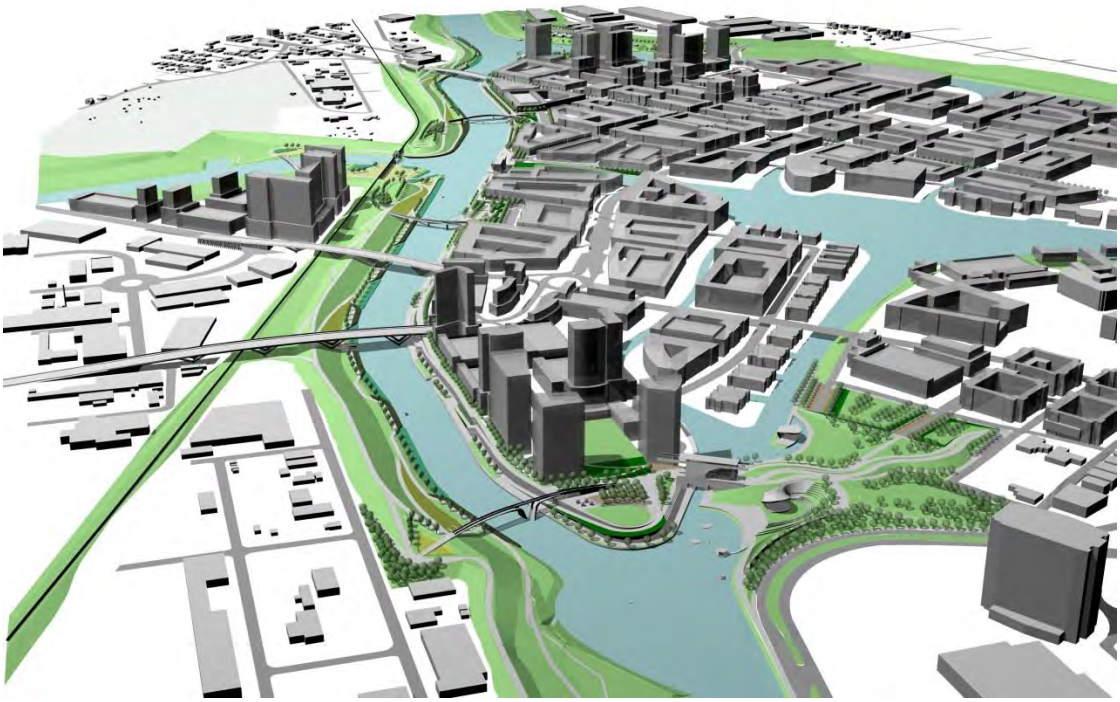
This project is a multi-agency collaboration between the District, TRV, Texas Department of Transportation (TxDOT), USACE, the City of Fort Worth, and Tarrant County, bringing flood protection and related infrastructure to an 800 acre area north of downtown Fort Worth between the Tarrant County Courthouse and Northside Drive. The key component is the construction of a bypass channel, approximately 1.5 miles long, which will divert flood flows around the segment of the Trinity River adjacent to downtown. Construction of this new bypass channel and related dam and isolation gates will allow the existing river to function as a "quiescent watercourse"-a calm, constant-level, lake-like body that can be enjoyed all year round.

As of September 30, 2014 the TRV project has accomplished the following:

- 268 businesses and tenants have been successfully relocated.
- Property continues to be acquired based on project schedule needs.
- Demolition work was completed in the Henderson Street, White Settlement, and Main Street corridors in preparation for bridge construction.
- Henderson Street, White Settlement, and Main Street Bridge design is 100% complete.
- TxDOT let a contract for all three bridges in May and mobilized in September.
- The Henderson Street detour was completed and will be used during bridge construction.
- Final design on bypass channel continues.
- Water and sanitary sewer lines were relocated by the City of Fort Worth and franchise utility relocation was completed in the areas required for bridge construction.
- Design work for valley storage at Gateway Park Sites A & C was completed, and Rockwood Park and Riverside Park design continues.
- Ham Branch Valley Storage design was completed in preparation for construction in the future.
- Design work on pedestrian bridges is at 60%.

As of year-end, the District and the Trinity River Vision Authority (TRVA) have spent a total of $64.4 million on this project. The City of Fort Worth Tax Increment Reinvestment Zone Number Nine in accordance with the project cost funding agreement as described in Note 1, which accompanies the financial statements, has spent $108.5 million on the project including $2.6 million of expenses paid directly by the Tax Increment Reinvestment Zone. The remaining outstanding loan to TRWD is $92.0 million. Pictures depicting detours being built and conceptual design sketches are below and on the following page:

Picture 5 – New blacktop laid to detour Henderson St. traffic during construction



Picture 6 – Conceptual overview of the bypass channel

Annex West Administration Building

The Annex West Administration Building consists of a single story office building containing offices, work room, training room, conference rooms and associated ancillary spaces to accommodate expanding staff needed for the many large projects the District is working on. The building also includes a vault designed to withstand a category F5 tornado. In addition, this project includes the expansion of the existing parking lot and a separate two level parking structure. The building is 16,046 square feet and the parking structure is 52,800 square feet. The Annex West Administration Building and the parking garage were completed in spring of 2014. Photos of the new building and garage are shown on the following page:

Picture 7 - Annex West Administration Building

Picture 8 - Administration Parking Garage

Twin Points Park

The Twin Points Park project has been ongoing since 2010. To date, the District has spent $5.7 million for cleanup, a boat ramp, docks, paved parking areas, fence and gated park access, and additional restrooms. Now in Phase 2B of the project, a swim area and beach area are in progress. Construction on these portions of the project began within the park during Fiscal Year 2014. Future plans include concessions and RV parking areas. See the progress that has been made on the Phase 2B swim beach retaining walls in the picture below.

Picture 9 – Twin Points Park Swim Beach Retaining Walls

Airfield Falls Conservation Park

A new conservation garden and trailhead will honor the history of the Naval Air Station Joint Reserve Base (NASJRB) with an educational art piece featuring military aircraft components. These components consist of wings and a tail section of a C-9 military aircraft that have been donated by the NASJRB. The new amenities will be a unique way to represent the rich history of the region from its transformation from a Bomber Plant to Lockheed Martin to Carswell to now the NASJRB. Other amenities such as parking, restroom, water fountain and picnic tables will be on site as well.

In addition to new recreation opportunities, the project also focuses on another of the District's missions with the addition of a conservation garden deemed the "Walk of a Thousand Plants". This garden will feature native plants so visitors of Airfield Falls will be able to see how and what to plant during different seasons to help conserve water. To date, the District has spent $1.6 million on this project. Below is a photograph of the garden under construction:

Picture 10 – Airfield Falls Terrace Area

Marine Creek Trailhead and Park

The District and Tarrant County Precinct 4 partnered to construct two miles of 12 foot wide asphalt trail that will provide access for Tarrant County College and the new neighborhoods to enjoy further improvements around Marine Creek Lake. This will also help the District's effort to link this trail to the rest of the Trinity Trail system. So far, the District has spent $2.2 million on trailhead improvements. In Fiscal Year 2015 the District plans to build a parking area, boat ramp, pavilions, and restrooms along the trail. Below is a portion of the trails around Marine Creek Lake.

Picture 11 – A portion of the trails around Marine Creek Lake

OVERVIEW OF THE FINANCIAL STATEMENTS

This discussion and analysis is intended to serve as an introduction to the District's basic financial statements. The District's basic financial statements contain three components: 1) Government-wide financial statements, 2) fund financial statements, and 3) notes to the financial statements. The report also contains other required supplementary information in addition to the basic financial statements.

Government-wide Financial Statements

The government-wide financial statements are designed to provide readers with a broad overview of the District's finances, presented in a manner similar to that of a private-sector business.

Statement of Net Position

The Statement of Net Position presents information on all of the District's assets and liabilities. The difference between those assets and liabilities are reported as net position. Over time, increases and decreases in net position could provide a useful indicator of whether the financial position of the District is improving or deteriorating.

Statement of Activities

The Statement of Activities presents information showing how the District's net position has changed during the most recent fiscal year. All changes in net position are reported as soon as the underlying event giving rise to the change occurs, regardless of the timing of related cash flows.

Both the Statement of Net Position and the Statement of Activities distinguish between the two functions of the District. Property taxes, oil and gas royalties, and inter-governmental revenues support the governmental activities. These activities include flood control, floodway maintenance, and improvements, recreation, and general government administration. The business-type activities of the District are intended to recover all or a significant portion of their costs through user fees and charges. The District's business-type activity is supplying raw water to municipalities. The government-wide financial statements can be found beginning on Page 26 and 27 of this report.

Fund Financial Statements

A fund is a grouping of related accounts that is used to maintain control over resources that have been segregated for specific activities or objectives. The funds of the District can be divided into two categories: governmental and proprietary.

Governmental Funds

Governmental funds are used to account for the same functions shown in the governmental activities on the Statement of Activities mentioned above. However, unlike the government-wide financial statements, governmental fund financial statements focus on near-term inflows and outflows and the expending of available resources, as well as on balances of resources available at the end of the fiscal year.

Because the focus of governmental funds is narrower than that of the government-wide financial statements, it is useful to compare the information presented for governmental funds with similar information presented for governmental activities in the government-wide financial statements. Both the governmental fund balance sheet and the governmental fund statement of revenues, expenditures, and changes in fund balances provide reconciliations to facilitate this comparison between governmental funds and governmental activities. The District maintains only one governmental fund: the General Fund.

Proprietary Funds

Proprietary funds are used to report the same functions presented as business-type activities in the government-wide financial statements. The District's proprietary funds account for the raw water system, its repairs, and its improvements.

Component Unit

Component units are organizations that are legally separate, tax exempt entities that have the following characteristics: 1) the economic resources received or held are almost entirely for the direct benefit of the primary government, 2) the primary government has the ability to access a majority of the economic resources held by the separate organization and 3) the assets held by the separate entity are significant to the primary government. The District has one discretely-presented component unit: the Trinity River Vision Authority.

Notes to the Financial Statements

The notes provide additional information that is essential to a full understanding of the data provided in the government-wide and fund financial statements. The notes to the financial statements can be found beginning on page 39 of this report.

FINANCIAL ANALYSIS: GOVERNMENT-WIDE STATEMENTS

As noted earlier, net position may serve over time as a useful indicator of a government's financial position. In the case of the District, assets and deferred outflows exceeded liabilities and deferred inflows by $831.0 million at the close of the 2014 fiscal year.

CONDENSED SCHEDULE OF NET POSITION

	Governmental Activites		Business-Type Activites		Total	
	2013	2014	2013	2014	2013	2014
Current and other assets	$ 204,514,896	$ 217,260,350	$ 317,363,230	$ 752,025,675	$ 521,878,126	$ 969,286,025
Capital assets	221,301,902	279,586,633	908,230,255	1,063,297,783	1,129,532,157	1,342,884,416
Total Assets	$ 425,816,798	$ 496,846,983	$ 1,225,593,485	$ 1,815,323,458	$ 1,651,410,283	$ 2,312,170,441
Deferred Outflows of Resources	$ -	$ -	$ 50,088	$ -	$ 50,088	$ -
Current liabilites	$ 5,107,216	$ 9,849,698	$ 59,034,952	$ 89,445,012	$ 64,142,168	$ 99,294,710
Long-term liabilities	11,380,940	27,899,372	825,495,524	1,351,542,092	836,876,464	1,379,441,464
Total Liabilities	$ 16,488,156	$ 37,749,070	$ 884,530,476	$ 1,440,987,104	$ 901,018,632	$ 1,478,736,174
Deferred Inflows of Resources	$ -	$ -	$ 2,800,573	$ 2,469,138	$ 2,800,573	$ 2,469,138
Net position:						
Net investment in capital assets	$ 221,301,902	$ 279,586,633	$ 275,649,460	$ 308,579,683	$ 496,951,362	$ 588,166,316
Restricted for debt service			63,522,458	90,811,279	63,522,458	90,811,279
Unrestricted	188,026,740	179,511,280	(859,394)	(27,523,746)	187,167,346	151,987,534
Total Net Position	$ 409,328,642	$ 459,097,913	$ 338,312,524	$ 371,867,216	$ 747,641,166	$ 830,965,129

Government-wide

- **Current and Other Assets (includes all assets other than Capital Assets)**
  Current and Other assets increased from $521.9 million to $969.3 million mainly due to bond proceeds from the 2014 bond issue of $520.9 million.

- **Capital Assets**
  Capital assets increased from $1.1 billion to $1.3 billion due to the ongoing acquisition of property for the Trinity River Vision project and design and construction related to the 2009, 2010, 2012 and 2014 bond issues which included projects such as the Wetlands at Richland-Chambers and Cedar Creek Reservoirs, the IPL project, and other various large projects.

- **Net Investment in Capital Assets**
  The District has $588.2 million (71%) of its net position in Capital Assets (e.g. dams, spillways and water transmission facilities as well as land, buildings, machinery, and equipment); less any related debt used to acquire those assets that is still outstanding. The District uses the majority of these capital assets to provide services to its water customers; consequently, those assets are not available for future spending.

Although the District's investment in capital assets is reported net of related debt, it should be noted that the resources needed to repay this debt must be provided from other sources, since the capital assets themselves cannot be used to liquidate these liabilities.

- **Restricted for Debt Service**
  An additional $90.8 million (11%) of the District's net position represents resources that are subject to restrictions for debt service.

- **Unrestricted Net Position**
  The remaining balance of $152.0 million (18%) is considered unrestricted net position and may be used to meet the District's ongoing liabilities.

Governmental Activities

- **Current and other assets**
  Increase of $12.7 million was due mainly to the $41.0 million increase in the long-term receivable related to the Tax Increment Reinvestment Zone Project Cost Funding Agreement, netted with a decrease of $29.3 million in cash and investments carried in the General Fund because of ongoing spending on General Fund capital asset projects.

- **Capital Assets**
  Increase of $58.3 million was due to the TRV Project and ongoing park and trail construction.

Business-Type Activities

- **Current and Other Assets**
  Current and Other assets increased from $317 million to $752 million largely due to bond proceeds from the issuance of $520.9 million of new debt netted with expenditures for the on-going IPL project.

- **Capital Assets**
  Capital assets increased from $908 million to $1.1 billion due to on-going bond projects with the largest being the Integrated Pipeline.

- **Long-Term Liabilities**
  Long-Term Liabilities increased from $825 million to $1.4 billion due mostly to the issuance of $521 million of new debt.

CONDENSED SCHEDULE OF ACTIVITIES

	Governmental Activities		Business-Type Activities		Total	
	2013	2014	2013	2014	2013	2014
Revenues:						
Program Revenues:						
Charges for services	$ 33,255,675	$ 26,048,278	$ 120,270,336	$ 136,041,137	$ 153,526,011	$ 162,089,415
Capital Contributions	31,910,810	49,101,393	-	-	31,910,810	49,101,393
Total Program Revenues	65,166,485	75,149,671	120,270,336	136,041,137	185,436,821	211,190,808
General Revenues:						
Property tax revenues	9,013,033	9,231,193	-	-	9,013,033	9,231,193
Unrestricted investment income	300,771	367,655	262,520	1,598,019	563,291	1,965,674
Other revenues	328,577	94,854	988,288	817,080	1,316,865	911,934
Total Revenues	74,808,866	84,843,373	121,521,144	138,456,236	196,330,010	223,299,609
Expenses:						
General government	11,521,503	13,462,903	-	-	11,521,503	13,462,903
Flood control	6,313,528	3,241,255	-	-	6,313,528	3,241,255
TRV Contribution	1,041,910	18,369,944	-	-	1,041,910	18,369,944
Water supply	-	-	87,165,497	104,901,544	87,165,497	104,901,544
Total Expenses	18,876,941	35,074,102	87,165,497	104,901,544	106,042,438	139,975,646
Changes in Net Position	55,931,925	49,769,271	34,355,647	33,554,692	90,287,572	83,323,963
Net Position - Beginning	353,396,717	409,328,642	312,220,780	338,312,524	665,617,497	747,641,166
Change in Accounting Principle due to implementation of GASB 65	-	-	(8,263,903)	-	(8,263,903)	-
Net Position - Beginning	353,396,717	409,328,642	303,956,877	338,312,524	657,353,594	747,641,166
Net Position - Ending	$ 409,328,642	$ 459,097,913	$ 338,312,524	$ 371,867,216	$ 747,641,166	$ 830,965,129

Governmental Activities

- **Charges for Services**
  Decrease of $7.2 million is due primarily to decreased oil and gas revenues.

- **Capital Contribution**
  Increase of $17.2 million due to an increase in the TIF contribution, as well as a land swap where the land contributed to TRWD was worth $4.6 million more than the land being traded away.

- **TRV Contribution Expense**
  Increase of $17.3 million is due to the contribution of the White Settlement Bridge asset, as well as a cash contribution for use on the White Settlement Bridge project, to Texas Department of Transportation.

Business Type Activities

- **Program Revenues – Charges for Services**
  Increased $18.6 million due to increased pumping power and debt service charged to customers.

- **Expenses – Water Supply**
  Expenses for the water supply increased $17.7 million mainly due to the District using more electricity for pumping power because of decreasing lake levels and drought conditions. Also, bond expenses increased $3 million due to increased bond activity in fiscal year 2014.

FINANCIAL ANALYSIS: FUND STATEMENTS

General Fund

As of the end of the 2014 fiscal year, the District's General Fund reported an ending fund balance of $115.7 million, a decrease of $33.3 million in comparison to the prior year. This total includes Non-spendable fund balance in the amount of $3.7 million, and $111.9 million in an Unassigned Fund Balance, which is available for spending at the District's discretion.

The General Fund includes floodway support and maintenance, flood control efforts, recreation, and general administrative costs. Tax revenues, oil and gas royalties, and a reimbursement from the Proprietary Funds for allocated costs provide the major sources of revenue.

Enterprise Fund

The District's enterprise fund provides the same type of information found in the government-wide financial statements, but without comparative data for the prior year.

End of year Net Position is $371.9 million.

FINANCIAL ANALYSIS: CAPITAL ASSETS

The District's capital assets for its governmental and business-type activities as of September 30, 2014 were $1.3 billion. Capital assets include: dams, spillways and water transmission facilities as well as land, roads, buildings, machinery, equipment, construction costs, and surplus water rights.

Major asset events during the current year included the following:

- **Land – Governmental Activities**
  - Trinity River Vision project land, relocation, demolition, and environmental costs including pollution remediation increased the land balance by $37.8 million.
- **Construction in Progress – Governmental Activities**
  - Trinity River Vision construction in progress increased by $7.5 million.
  - Twin Points Project increased by $1.3 million.
  - Airfield Falls Trailhead increased by $1.3 million.
  - The Annex West Administration building was completed and $6.6 million of prior year costs were transferred to depreciable buildings.
- **Buildings – Governmental Activities**
  - The District completed construction on the new $7.6 million Annex West Administration Building and parking garage, with $1.0 million of that cost in the current fiscal year.
- **Land – Business-type Activities**
  - Integrated Pipeline land purchases of $18.0 million.
  - Purchased $15.0 million related to the Cedar Creek Wetlands.
- **Construction in Progress – Business-type Activities**
  - Richland-Chambers Wetland's current phase was completed and $43.3 million of prior year costs were transferred to depreciable wetlands.
  - Integrated Pipeline increased $97.4 million.
  - Arlington Outlet Hydroelectric Generation increased $1.2 million.
  - Kennedale Balancing Reservoir Line J Section 1C increased $6.0 million.
  - Cedar Creek Dam Stability Analysis increased $3.2 million.
  - Pump Room Cooling Project increased $1.6 million.
  - Capitalized Interest on construction in progress increased $3.7 million net of transfers to other project costs.
- **Pipeline**
  - Updating Variable Frequency Drive at Richland Chambers was completed for a total cost of $3.1 million of which $2.3 million was cost in the current fiscal year.
- **Wetlands**
  - The District completed construction on the current $45.3 million phase of the Richland-Chambers Wetlands, with $2.0 million of that cost in the current fiscal year.
- **Other Project Costs**
  - Capitalized Interest increased $17.5 million.

CAPITAL ASSETS

	Governmental Activities		Business-Type Activities		Total	
	2013	2014	2013	2014	2013	2014
Nondepreciable:						
Land	$ 141,387,171	$ 187,854,778	$ 100,739,236	$ 133,783,193	$ 242,126,407	$ 321,637,971
Construction in progress	55,144,489	58,960,125	294,255,165	363,799,258	349,399,654	422,759,383
Total nondepreciable assets	196,531,660	246,814,903	394,994,401	497,582,451	591,526,061	744,397,354
Depreciable :						
Dams and spillways	3,378,736	3,378,736	210,382,594	212,929,639	213,761,330	216,308,375
Pipeline	-	-	507,235,559	510,290,880	507,235,559	510,290,880
Wetlands	-	-	8,823,497	54,091,602	8,823,497	54,091,602
Communications	-	-	1,087,448	1,087,448	1,087,448	1,087,448
Buildings	25,361,800	34,533,160	6,769,080	6,816,587	32,130,880	41,349,747
Machinery and equipment	10,157,896	11,155,730	12,714,871	12,922,394	22,872,767	24,078,124
Flood control and other project costs	8,095,940	8,095,940	47,648,525	65,096,010	55,744,465	73,191,950
Capital Lease-Machinery & Equip	1,447,140	1,447,140	-	-	1,447,140	1,447,140
	48,441,512	58,610,706	794,661,574	863,234,560	843,103,086	921,845,266
Less:						
Accumulated depreciation	(23,147,691)	(25,025,969)	(281,987,943)	(298,011,898)	(305,135,634)	(323,037,867)
Capital Lease-Accum. Depr.	(523,579)	(813,007)	-	-	(523,579)	(813,007)
Total depreciable assets	24,770,242	32,771,730	512,673,631	565,222,662	537,443,873	597,994,392
Water rights, net of Accum Depr.	-	-	562,223	492,670	562,223	492,670
Total	$ 221,301,902	$ 279,586,633	$ 908,230,255	$ 1,063,297,783	$ 1,129,532,157	$ 1,342,884,416

BUDGETARY HIGHLIGHTS

GENERAL FUND

The 2014 budgeted revenues for the General Fund were $30.9 million and the year ended with actual revenues of $39.2 million.

The 2014 budgeted expenditures for the General Fund were $80.7 million and the year ended with actual expenditures of $72.5 million.

The Fiscal Year 2015 General Fund budgeted expenditures total $69.6 million, which is a decrease of $11.1 million over the fiscal year 2014 approved budget of $80.7 million. This decrease is due mainly to a $10.7 million decrease in ongoing construction within the General Fund. The property tax rate will remain at $.02/$100 valuation.

ENTERPRISE FUND

The fiscal year 2015 Enterprise Fund Budget, prepared in accordance with the Tarrant Regional Water Supply Facilities Amendatory Contract, totals $136.1 million. This reflects an increase of $9.7 million from the fiscal year 2014 approved budget of $126.4 million. The increase is mainly due to debt repayment which represents $7.4 million and facilities increase of $2.7 million. The total budget includes administrative expenses, operating and maintenance expenses, capital expenditures, and Debt Service that provides for principal and interest payments to retire outstanding bonds.

REQUESTS FOR INFORMATION

This financial report is designed to provide a general overview of Tarrant Regional Water District's finances. Questions concerning any of the information provided in this report or requests for additional financial information should be addressed as follows:

Sandra Newby
Director of Finance
800 East Northside Drive
Fort Worth, Texas 76102

TARRANT REGIONAL WATER DISTRICT

STATEMENT OF NET POSITION
SEPTEMBER 30, 2014

	Primary Government			
	Governmental Activities	Business-Type Activities	Total	Component Unit
ASSETS:				
Cash and cash equivalents	$ 53,637,150	$ 26,265,019	$ 79,902,169	$ 2,936,220
Investments	55,076,546	6,997,879	62,074,425	
Receivables:				
Accounts, oil and gas royalties, and other	4,131,442	1,612,535	5,743,977	58,960
Taxes-net of allowance	36,692		36,692	
Accrued interest	104,099	27,775	131,874	
Long-term receivable	91,999,716		91,999,716	
Internal balances	9,412,389	(9,412,389)	-	
Prepaid items	2,808,611	2,176,256	4,984,867	20,410
Inventory of supplies-at cost	53,705		53,705	
Cash and cash equivalents for bond projects		239,322,955	239,322,955	
Investments held for bond projects		388,917,277	388,917,277	
Accrued interest receivable for bond projects		395,809	395,809	
Cash and cash equivalents restricted		1,100,000	1,100,000	
Cash and cash equivalents for debt service		566,915	566,915	
Investments restricted for debt service		93,736,654	93,736,654	
Accrued interest receivable restricted for debt service		318,990	318,990	
Land	187,854,778	133,783,193	321,637,971	
Construction in progress	58,960,125	363,799,258	422,759,383	
Depreciable capital assets, net of accumulated depreciation	32,771,730	565,222,662	597,994,392	
Water rights, net of amortization		492,670	492,670	
Total Assets	496,846,983	1,815,323,458	2,312,170,441	3,015,590
LIABILITIES:				
Accounts payable	7,575,494	41,306,018	48,881,512	1,003,553
Accrued vacation - due within one year	201,354	580,424	781,778	
Accrued litigation judgements	195,000		195,000	
Other liabilities	1,877,850	5,492,290	7,370,140	1,987,698
Payable from restricted assets - Accrued bond interest payable		4,911,280	4,911,280	
Revenue bonds payable, net of discount				
Due within one year		37,155,000	37,155,000	
Due in more than one year		1,343,730,004	1,343,730,004	
Long-term Payables				
Pollution Remediation Obligations	24,109,409		24,109,409	
Post employment benefits payable	3,319,110	6,454,804	9,773,914	
Accrued Vacation - due in more than one year	470,853	1,357,284	1,828,137	
Total Liabilities	37,749,070	1,440,987,104	1,478,736,174	2,991,251
DEFERRED INFLOWS OF RESOURCES:				
Deferred bond refunding-gain		2,469,138	2,469,138	
NET POSITION:				
Net investment in capital assets	279,586,633	308,579,683	588,166,316	-
Restricted for debt service		90,811,279	90,811,279	-
Unrestricted	179,511,280	(27,523,746)	151,987,534	24,339
Total Net Position	$ 459,097,913	$ 371,867,216	$ 830,965,129	$ 24,339

The accompanying notes are an integral part of these financial statements.

TARRANT REGIONAL WATER DISTRICT

STATEMENT OF ACTIVITIES
FOR THE YEAR ENDED SEPTEMBER 30, 2014

Functions/Programs	Expenses	Program Revenues: Charges for services	Program Revenues: Capital Grants and Contributions	Net (Expense) Revenue and Changes in Net Position: Primary Government: Governmental Activities	Primary Government: Business Type Activities	Primary Government: Total	Component Unit
PRIMARY GOVERNMENT							
Governmental activities:							
General government	$ 13,462,903	$ 26,048,278	$ 49,101,393	$ 61,686,768		$ 61,686,768	
Flood control	3,241,255			(3,241,255)		(3,241,255)	
Trinity River Vision Project	18,369,944			(18,369,944)		(18,369,944)	
Total governmental activities	35,074,102	26,048,278	49,101,393	40,075,569		40,075,569	
Business type activities-water supply	104,901,544	136,041,137			$ 31,139,593	31,139,593	
	$ 139,975,646	$ 162,089,415	$ 49,101,393		31,139,593	71,215,162	
COMPONENT UNIT							
Trinity River Vision Authority							
Project development	37,801,538	36,140,562					$ (1,660,976)
Recreation programs	744,620	487,281	257,339				-
Total component unit	$ 38,546,158	$ 36,627,843	$ 257,339				(1,660,976)
GENERAL REVENUES (EXPENSES):							
Property taxes				9,231,193		9,231,193	
Investment income				367,655	1,598,019	1,965,674	643
Miscellaneous				48,081	773,572	821,653	1,800
Gain/loss on disposal of assets				46,773	43,508	90,281	
Total general revenues and transfers				9,693,702	2,415,099	12,108,801	2,443
CHANGES IN NET POSITION				49,769,271	33,554,692	83,323,963	(1,658,533)
NET POSITION----Beginning of year				409,328,642	338,312,524	747,641,166	1,682,872
NET POSITION-----End of year				$ 459,097,913	$ 371,867,216	$ 830,965,129	$ 24,339

The accompanying notes are an integral part of these financial statements.

TARRANT REGIONAL WATER DISTRICT

BALANCE SHEET—GENERAL FUND
SEPTEMBER 30, 2014

ASSETS:	
Cash and cash equivalents	$ 53,637,150
Investments	55,076,546
Receivables:	
Oil and gas royalties and other	4,131,442
Taxes—net	36,692
Accrued interest	104,099
Due from Enterprise Fund	8,538,375
Notes and interest due from enterprise fund	874,014
Prepaid items	2,808,611
Inventory of supplies —at cost	53,705
Long-term receivable	91,999,716
Total assets	$ 217,260,350
LIABILITIES:	
Accounts payable	$ 7,575,494
Accrued litigation and judgements	195,000
Other liabilities	1,389,467
Total liabilities	9,159,961
DEFERRED INFLOWS:	
Unavailable revenue	92,427,433
Total deferred inflows	92,427,433
FUND BALANCES:	
Nonspendable:	
Long-term interfund notes and interest	874,014
Prepaid items	2,808,611
Inventory of supplies - At cost	53,705
Unassigned	111,936,626
Total fund balances	115,672,956
TOTAL	$ 217,260,350

The accompanying notes are an integral part of these financial statements.

TARRANT REGIONAL WATER DISTRICT

RECONCILIATION OF BALANCE SHEET-GENERAL FUND TO GOVERNMENT-WIDE STATEMENT OF NET POSITION SEPTEMBER 30, 2014

TOTAL FUND BALANCES—General Fund	$	115,672,956
Amounts reported for governmental activities in the statement of net assets are different because:		
Certain revenues do not provide current financial resources and therefore are unavailable at the fund level		
TIF Loan Long-Term Receivable		91,999,716
Property Taxes		11,996
Oil and Gas Revenues known but not paid wihtin 60 days of year end		415,721
Certain liabilities are not payable from current resources and are therefore not accrued at the fund level		(28,100,726)
Certain leases are not due and payable in the current period and therefore are not reported as liabilities to governmental funds		(488,383)
Capital assets used in governmental activities are not financial resources and therefore are not reported as assets in governmental funds		279,586,633
TOTAL NET POSITION—Governmental activities	$	459,097,913

The accompanying notes are an integral part of these financial statements.

TARRANT REGIONAL WATER DISTRICT

STATEMENT OF REVENUES, EXPENDITURES, AND CHANGES IN FUND BALANCE—GENERAL FUND
FOR THE YEAR ENDED SEPTEMBER 30, 2014

REVENUES:	
Property taxes	$ 9,263,039
Lease rentals	1,314,725
Oil and gas royalties	24,518,478
Sale of Rock and Gravel	12,500
Investment income	367,655
Contributions	3,386,255
Other	311,573
Total revenues	39,174,225
EXPENDITURES:	
Current:	
General and administrative	9,043,006
Personnel services	4,821,935
Pension plan contribution	512,818
Contribution to Component Unit	18,434,944
Capital expenditures	39,365,013
Capital lease payment	277,377
Total expenditures	72,455,093
DEFICIENCY OF REVENUES UNDER EXPENDITURES	(33,280,868)
CHANGE IN FUND BALANCE	(33,280,868)
FUND BALANCE—Beginning of year	148,953,824
FUND BALANCE—End of year	$ 115,672,956

The accompanying notes are an integral part of these financial statements.

TARRANT REGIONAL WATER DISTRICT

RECONCILIATION OF STATEMENT OF REVENUES, EXPENDITURES, AND CHANGES IN FUND BALANCE—GENERAL FUND—TO GOVERNMENT WIDE STATEMENT OF ACTIVITIES FOR THE YEAR ENDED SEPTEMBER 30, 2014

CHANGE IN FUND BALANCE—General Fund	$	(33,280,868)
Amounts reported for governmental activities in the statement of net position are different because:		
Revenues in the statement of activities that do not provide current financial resources are not reported as revenues at the fund level.		
Change in unavailable revenue-TIF		41,066,374
Change in unavailable property taxes		(31,846)
Change in unavailable oil and gas revenue		(10,650)
Change in depreciation		(3,493)
Certain liabilites are not payable from current resources and are therefore not accrued in the fund.		130,487
Certain lease proceeds provide current financial resources to governmental funds, while entering into the leases increases long-term liabilities in the government-wide statement of net position. Repayment of principal is an expenditure in the governmental funds, but the repayment reduces long-term liabilities in the statement of net position.		246,940
This is the amount by which the contributed revenue ($4,648,764) for land exceeded the contributed expenses related to land ($35,406).		4,613,358
The general fund reports capital outlays as expenditures. However, in the statement of activities the cost of those assets is allocated over their estimated useful lives and reported as depreciation expense. This is the amount by which Capital Outlays ($39,365,013) exceeded Depreciation ($2,326,044).		37,038,969
CHANGE IN NET POSITION—Governmental activities	$	49,769,271

The accompanying notes are an integral part of these financial statements.

TARRANT REGIONAL WATER DISTRICT

STATEMENT OF NET POSITION—ENTERPRISE FUND
SEPTEMBER 30, 2014

ASSETS:

Current:		
Cash and cash equivalents	$	26,265,019
Investments		6,997,879
Receivables:		
Accounts and other		1,612,535
Accrued interest		27,775
Prepaid items		2,176,256
Total current assets		37,079,464
Noncurrent:		
Cash and cash equivalents-Bond projects		239,322,955
Investments-Bond projects		388,917,277
Accrued interest receivable-Bond projects		395,809
Cash and cash equivalents-Contingency		1,100,000
Cash and cash equivalents-Restricted for non-current debt service		566,915
Investments-Restricted for non-current debt service		93,736,654
Accrued interest receivable-Restricted for non-current debt service		318,990
Capital Assets:		
Land		133,783,193
Construction in progress		363,799,258
Depreciable capital assets—net		565,222,662
Water rights—net of amortization		492,670
Total noncurrent assets		1,787,656,383
Total assets	$	1,824,735,847

(Continued)

The accompanying notes are an integral part of these financial statements.

TARRANT REGIONAL WATER DISTRICT

STATEMENT OF NET POSITION—ENTERPRISE FUND
SEPTEMBER 30, 2014

LIABILITIES:		
Current Liabilities:		
Accounts payable	$	41,306,018
Due to General Fund		8,538,375
Accrued vacation		580,424
Other liabilities		5,492,290
Payable from restricted assets—accrued bond interest payable		4,911,280
Revenue bonds payable		37,155,000
Notes and interest payable to General Fund		127,568
Total current liabilities		98,110,955
Noncurrent Liabilities:		
Accrued vacation		1,357,284
Long-term post employment benefits		6,454,804
Revenue bonds payable-net of discount		1,343,730,004
Notes and interest payable to General Fund		746,446
Total noncurrent liabilities		1,352,288,538
Total liabilities		1,450,399,493
DEFERRED INFLOWS OF RESOURCES:		
Deferred bond refunding-gain		2,469,138
NET POSITION:		
Net investment in capital assets		308,579,683
Restricted for debt service		90,811,279
Unrestricted		(27,523,746)
TOTAL NET POSITION	$	371,867,216

(Concluded)

The accompanying notes are an integral part of these financial statements.

TARRANT REGIONAL WATER DISTRICT

STATEMENT OF REVENUES, EXPENSES, AND CHANGES IN NET POSITION—ENTERPRISE FUND FOR THE YEAR ENDED SEPTEMBER 30, 2014

OPERATING REVENUES:	
Sale of water	$ 121,710,988
Sale of system capacity	14,072,987
Land lease rentals	88,640
Other	942,094
Total operating revenues	136,814,709
OPERATING EXPENSES:	
General and administrative	27,693,314
Personnel services	11,136,074
Utilities	29,499,922
Depreciation and amortization	16,428,450
Pension plan contribution	1,223,685
Total operating expenses	85,981,445
OPERATING INCOME	50,833,264
NONOPERATING INCOME (EXPENSE):	
Investment income	1,598,019
Interest expense	(18,920,099)
Gain on disposal of capital assets	43,508
Total nonoperating income (expense)	(17,278,572)
NET INCOME	33,554,692
NET POSITION----Beginning of year	338,312,524
NET POSITION—End of year	$ 371,867,216

The accompanying notes are an integral part of these financial statements.

TARRANT REGIONAL WATER DISTRICT

STATEMENT OF CASH FLOWS—ENTERPRISE FUND
FOR THE YEAR ENDED SEPTEMBER 30, 2014

CASH FLOWS FROM OPERATING ACTIVITIES:	
Receipts from customers	$ 135,932,901
Miscellaneous receipts	942,094
Payments to suppliers and contractors	(31,157,899)
Payments to employees for services	(11,571,558)
Payment to General Fund	710,669
Net cash provided by operating activities	94,856,207
CASH FLOWS FROM CAPITAL AND RELATED FINANCING ACTIVITIES:	
Proceeds from the sale of revenue bonds	575,531,337
Principal paid on revenue bonds payable	(30,310,000)
Interest paid on revenue bonds and contract payable	(42,483,045)
Acquisition and construction of capital assets	(150,296,186)
Payments for accrued litigation related to capital assets	(6,175,000)
Cost paid for bond related items	(3,694,052)
Proceeds from disposal of capital assets	43,508
Net cash used for capital and related financing activities	342,616,562
CASH FLOWS FROM INVESTING ACTIVITIES:	
Purchase of investments	(477,700,000)
Proceeds from sale and maturity of investments	156,565,000
Interest received on investments	1,371,522
Net cash provided by investing activities	(319,763,478)
NET DECREASE IN CASH AND CASH EQUIVALENTS	117,709,291
CASH AND CASH EQUIVALENTS—Beginning of year	149,545,598
CASH AND CASH EQUIVALENTS—End of year	$ 267,254,889

(Continued)

The accompanying notes are an integral part of these financial statements.

TARRANT REGIONAL WATER DISTRICT

STATEMENT OF CASH FLOWS—ENTERPRISE FUND
FOR THE YEAR ENDED SEPTEMBER 30, 2014

RECONCILIATION OF OPERATING INCOME TO NET CASH		
PROVIDED BY OPERATING ACTIVITIES:		
Operating income	$	50,833,264
Adjustments to reconcile operating income to net cash provided by operating activities:		
Depreciation & Amortization expense		16,428,450
Write off bad debt expense		5,810,857
Change in assets and liabilities:		
Accounts and other receivables		60,286
Prepaid expenses		(2,173,469)
Accounts payable		19,958,114
Due to (from) other funds—net		811,140
Interfund note payable		(100,471)
Vacation accrual		62,655
OPEB liability		725,546
Other liabilities		2,439,835
Net cash provided by operating activities	$	94,856,207

NONCASH ACTIVITIES:
Disposal of $344,611 of capital assets, net of $334,941 accumulated depreciation.
Capitalization of $21,199,791 of interest on construction projects.
Record change in fair value of investments and change in premium/discounts on investments to interest income of ($422,442) and $209,878 respectively.

(Concluded)

The accompanying notes are an integral part of these financial statements.

TARRANT REGIONAL WATER DISTRICT

STATEMENT OF NET POSITION - FIDUCIARY FUND
FOR THE YEAR ENDED SEPTEMBER 30, 2014

	Other Post-Employment Benefits Trust Fund
ASSETS	
Current assets:	
Cash & cash equivalents	$ 999,864
Total assets	999,864
NET POSITION	
Net assets held in trust for other employee benefits:	
Postemployment healthcare plans	999,864
Total Net Position	$ 999,864

The accompanying notes are an integral part of these financial statements.

TARRANT REGIONAL WATER DISTRICT

STATEMENT OF CHANGES IN NET POSITION - FIDUCIARY FUND
FOR THE YEAR ENDED SEPTEMBER 30, 2014

	Other Post-Employment Benefits Trust Fund
ADDITIONS	
Employer contributions	$ 1,000,000
Total Additions	1,000,000
DEDUCTIONS	
Net gain (loss) in fair value of investments	(136)
Total Deductions	(136)
CHANGE IN NET POSITION	999,864
NET POSITION—Beginning of year	-
NET POSITION—End of year	$ 999,864

The accompanying notes are an integral part of these financial statements.

NOTES TO BASIC FINANCIAL STATEMENTS
AS OF AND FOR THE YEAR ENDED SEPTEMBER 30, 2014

1. SUMMARY OF SIGNIFICANT ACCOUNTING POLICIES

Reporting Entity-The Tarrant Regional Water District (the "District") was created on October 7, 1924 as a municipality with full power to levy ad valorem taxes on all property within the District's boundaries. The District is governed by a board of five directors elected by qualified voters of Tarrant County (the "County") who reside within the District's boundaries. The District was formed to establish a local government agency to provide an adequate supply of raw water to Fort Worth and Tarrant County, Texas. The District also participates in flood control improvement programs, recreation, and has overseen the construction of the Fort Worth Floodway.

The accounting policies of the District conform to accounting principles generally accepted in the United States of America as applicable to governmental units and promulgated by the Governmental Accounting Standards Board ("GASB"). The following is a summary of the more significant policies.

Financial Reporting Entity - In evaluating the District's financial reporting entity, management has considered all potential component units. The following legally separate entity, Trinity River Vision Authority (TRVA), is included as a discrete component unit of the District in a separate column in the government-wide financial statements to emphasize that it is legally separated from the primary government. This component unit has a financial benefit/burden to the District and their relationship with the District is such that exclusion would be misleading. Separately issued financial statements are available for this component unit. Additional financial information regarding the TRVA should be addressed to the Director of Finance, 800 East Northside Drive, Fort Worth, Texas 76102.

Trinity River Vision Authority - House Bill 2639 of the 79th Texas Legislature authorized the Board of Directors of the District to create one or more nonprofit corporations to act on behalf of the District as the District's authority and instrumentality. By resolution dated July 18, 2006, the Board of Directors of the District authorized the incorporation of Trinity River Vision Authority. Subsequently, TRVA was incorporated by the Texas Secretary of State on July 21, 2006 and is governed in part by the Texas Development Corporation Act of 1979 (the "Act"). The TRVA is authorized to act on behalf of the District as the District's authority and instrumentality for the public purposes of educating the general public regarding the Trinity River Vision Project in Fort Worth, Texas, publishing educational materials about said Project, assisting in the coordination and implementation of the Project, and performing such other activities and purposes as permitted by applicable law or authorized by the Board of Directors of TRVA.

Measurement Focus and Basis of Accounting - The District's accounts are organized on the basis of funds, each of which are considered to be a separate accounting entity. The operations of each fund are accounted for by providing a separate set of self-balancing accounts which comprise each fund's assets, liabilities, fund equity, revenues and expenditures, or expenses. The accounting and financial reporting treatment applied to a fund is determined by its measurement focus. The proprietary fund and the government-wide financial statements are

reported using the economic resources measurement focus. The governmental fund financial statements are reported using the current financial resources measurement focus.

Government-wide Financial Statements - Government-wide financial statements consist of the statement of net position and the statement of activities. These statements report information on all of the activities of the District. Eliminations have been made to these statements to prevent double counting of internal activities. Governmental activities, which normally are supported by taxes and intergovernmental revenues, are reported separately from business-type activities, which rely to a significant extent on fees and charges for support.

The statement of activities presents a comparison between direct expenses and program revenues of the business-type activities of the District and for each function of the District's governmental activities. Direct expenses are those that are specifically associated with a program or function and therefore are clearly identifiable to a particular function. Program revenues include charges paid by the recipients of goods or services offered by the programs and grants and contributions that are restricted to meeting the operational or capital requirements of a particular program. Revenues that are not classified as program revenues are presented as general revenues.

The government-wide financial statements are prepared using the economic resources measurement focus and the accrual basis of accounting. Under this measurement focus, revenues are recorded when earned and expenses are recorded at the time the liabilities are incurred, regardless of the timing of cash flows. Property taxes are recognized as revenues in the year for which they are levied. Grants and similar items are recognized as revenue as soon as all eligibility requirements imposed by the provider have been met.

Fund-level Financial Statements - The fund financial statements provide information about the District's individual funds, which are used to account for the District's various activities. Separate financial statements are provided for the General Fund (a governmental fund) and the Enterprise Fund (a proprietary fund), which are each classified as major funds.

Governmental Fund - The General Fund, the only governmental fund reported by the District, is used to account for all financial resources of the District, not specifically levied or collected for other District funds and for revenues and expenditures related to flood control operations and activities or improvements and recreation.

The General Fund is accounted for using the modified accrual basis of accounting. Under the modified accrual basis of accounting, revenues are recognized when susceptible to accrual (i.e., when they become both measurable and available). "Measurable" means the amount of the transaction can be determined and "available" means collectible within the current period or soon enough thereafter to be used to pay liabilities of the current period. The District considers property taxes as available if they are collected within 60 days after year-end. Expenditures are recorded when the related fund liability is incurred.

Governmental funds report unavailable revenue in connection with receivables for revenues that are not considered to be available to liquidate liabilities of the current period. Governmental funds also record unearned revenue in connection with resources that have been received, but not yet earned.

The General Fund is reported using the current financial resources measurement focus. The reported fund balance is considered a measure of "available spending resources". The General Fund operating statement presents increases (revenues and other financing sources) and decreases (expenditures and other financing uses) in net current assets. Accordingly, it is said to present a summary of sources and uses of "available spendable resources" during a period.

Proprietary Fund - The Enterprise Fund, the only proprietary fund reported by the District, is used to account for revenues and expenses relating to maintenance and operation of the water supply system. Currently, the District has outstanding Construction and Improvement Bonds Series 2006 Water Revenue Bonds, Series 2008A-RC Water Revenue Bonds, Series 2008B-CC Water Revenue Bonds, Series 2009 Water Revenue Bonds Refunding and Improvement Bonds, Series 2010 Water Revenue Bonds, Series 2010A Water Revenue Bonds, Series 2010B Water Revenue Bonds, Series 2012 Water Revenue Refunding and Improvement Bonds, Series 2012 Contract Revenue Bond, 2012A Refunding Bond, Series 2014 Water Revenue Bonds, and Series 2014 Contract Revenue Bonds. These bond issues provided funding for large infrastructure-type projects.

Proprietary funds report operations (a) that are financed and operated in a manner similar to private business enterprises where the intent of the governing body is that the costs (expenses, including depreciation) of providing goods or services to the general public on a continuing basis be financed or recovered primarily through user charges; or (b) where the governing body has decided that periodic determination of revenues earned, expenses incurred, and net income is appropriate for capital maintenance, public policy, management control, accountability, or other purposes.

The Enterprise Fund is accounted for using the accrual basis of accounting. Revenues are recognized when earned, and expenses when they are incurred. Claims incurred but not reported are included in payables and expenses.

The Enterprise Fund is reported using an economic resources measurement focus. This means that all assets and liabilities (whether current or noncurrent) associated with the activity are included in the Fund's Statement of Net Position.

Revenues and expenses for the District's Enterprise Fund are categorized as either operating or non-operating. Normally, operating income would exclude from its components those transactions for which cash flows are reported as capital and related financing activities, noncapital financing activities, or investing activities. For the District, operating revenues include sale of water and land lease rentals. Operating expenses include general and administrative, personnel services, utilities, depreciation and amortization, and pension plan contributions.

Fiduciary Fund - The Fiduciary Fund accounts for assets held by the District in a trustee capacity for others or other Funds. The District's only Fiduciary Fund is the Other Employee Benefit Trust Fund which holds assets to be used for the future payments of benefits offered through the District's post-employment healthcare benefit plan. The Fiduciary fund is not included in the government-wide financial statements.

Cash, Cash Equivalents, and Investments - Cash and cash equivalents consist of deposits (principally interest-bearing accounts) with one financial institution and investments in three

public funds investment pools. Investments consist of U.S. Government and government agency obligations recorded at fair value. For accounting purposes, fair value is defined as the price at which two willing parties would complete an exchange.

For purposes of the statement of cash flows, the Enterprise Fund considers all highly liquid (i.e. maturity date of three months or less from the date of purchase) deposits and investments (including restricted assets and the investments in public funds investment pools) to be cash equivalents.

Long Term Receivables - During the fiscal year 2014 the District made expenditures on behalf of the City of Fort Worth Tax Increment Reinvestment Zone #9 (TIRZ) a project partner in the Trinity River Vision (TRV) Project under a Project Cost Funding Agreement between TRWD and Tax Increment Reinvestment Zone #9. Under the agreement TRWD is advancing funds for the TRV Project that would normally be paid by the Tax Increment Reinvestment Zone for costs related to the Project Plan. The Tax Increment Reinvestment Zone currently does not have, and is not projected to have, timely funds to implement the Project Plan as contemplated by the current schedule approved by the USACE. The Tax Increment Reinvestment Zone Board has authorized an agreement with TRWD dedicating revenue from the Tax Increment Reinvestment Zone Fund to cover the advances made by TRWD. The advances must be annually approved by the Tax Increment Reinvestment Zone board and are repayable without interest from future tax revenues of the Tax Increment Reinvestment Zone. During fiscal year 2014, the District expended an additional $44,214,170 under the agreement bringing the total amount expended to $105,955,480; $13,955,764 of that amount has been paid in cash by the Tax Increment Reinvestment Zone, with a remaining outstanding long-term receivable of $91,999,716 as of September 30, 2014. Of the total cash payments from the Tax Increment Reinvestment Zone, $3,147,798 was paid in 2014.

The other large long-term receivable held by the District has been a receivable from Luminant, formerly TXU, which grew to $8.3 million in fiscal year 2014. During the fiscal year Luminant filed for bankruptcy, causing the District to question the collectability of this receivable. As such, the District has written off 100% of the receivable in fiscal year 2014.

Property Taxes - Property subject to taxation is certain real and personal property served by the District in the County. Certain properties of religious, educational, and charitable organizations are exempt from taxation.

The District's ad valorem taxes are levied on October 1, on 100% of assessed valuation at a rate approved by the District's Board per $100 valuation as of the preceding January 1, and are due and payable from October 1 of the year in which levied, until January 31 of the following year without interest or penalty. Taxes paid after February 1 of each year are subject to interest and penalty charges.

In 2014, the District's ad valorem tax rate was $0.02 per $100 valuation. Collections of the current year's levy are reported as current collections if received by June 30 (within 9 months of the October 1 due date). Collections received thereafter are reported as delinquent collections.

Generally, property taxes, net of amounts estimated to be uncollectible, are recorded as a receivable on the assessment date and recognized as revenue when they become available

(collected within 60 days of year-end). The allowance for uncollectible taxes as of September 30, 2014 was $91,924. Under GASB 33, Accounting and Financial Reporting for Non-exchange Transactions, property taxes are imposed non-exchange revenue. Assets from imposed non-exchange transactions are recorded when the entity has enforceable legal claim to the asset, or when the District receives resources, whichever comes first. The assessment date has been designated at a date subsequent to fiscal year-end. The District has not recorded a receivable for accrual of future taxes at year-end because the assessment date had not yet occurred as of fiscal year-end.

The District's taxes on real property are a lien (as of the date of levy) against such property until paid. The District may foreclose on real property upon which it has a lien for unpaid taxes. Delinquent taxes on property not otherwise collected are generally paid when there is a sale or transfer of the title to the property. Any liens and subsequent suits against the taxpayer for payment of delinquent personal property taxes are barred unless instituted within four years from the time such taxes became delinquent.

Oil and Gas Royalties - The District receives royalties related to various oil and gas leases for which the District acts as lessor. The royalties are generally payable to the District when production begins at the lease site, and revenue is recognized as revenue at the time the royalty is earned and considered measurable and available if received within 60 days after year-end.

Capital Assets - Capital assets, which include property, plant, equipment, construction in progress, and infrastructure assets, are reported in the applicable governmental and business-type activities columns in the government-wide financial statements and in the fund financial statements for the Enterprise Fund. The District capitalizes all Machinery and Equipment capital purchases greater than or equal to $10,000 and all other assets purchased which cost $20,000 or greater.

Major outlays for capital assets and improvements are capitalized in the Enterprise Fund as projects are constructed. These costs primarily include construction costs, engineering fees, and legal fees and settlements related to acquisition, condemnation, and mineral rights. Net interest incurred during the construction phase on Enterprise Fund capital assets is capitalized. Total interest capitalized during the year ended September 30, 2014 was $21.2 million.

The costs of repairs and maintenance that do not extend the lives of or improve the value of related capital assets are expensed as incurred.

Depreciation - Depreciation of capital assets is charged as an expense against operations in the applicable governmental and business-type activities columns in the government-wide financial statements and in the fund financial statements for the Enterprise Fund. Capital assets are reported net of accumulated depreciation on the statements of net position. Depreciation is recorded utilizing the straight-line method. Estimated useful lives are as follows:

Dams, spillways, and related costs	50 years
Pipeline and pipeline right-of-way	50 years
Wetlands	50 years
Communications	50 years
Other	50 years
Buildings	20 years
Machinery and equipment	5 years

Deferred Compensation Plan - The District offers its employees a deferred compensation plan created in accordance with Internal Revenue Code Section 457. The plan, available to all District employees at their option, permits participants to defer a portion of their salary until future years. The deferred compensation is not available to participants until termination, retirement, death, or unforeseeable emergency. The assets of this plan are excluded from the District's financial statements.

Water Rights - Water rights represent rights to surplus water in Benbrook Lake purchased in 1992 through a long term contract with the federal government. The rights are recorded at cost and amortized over the 30-year life of the contract using the straight-line method.

Inter-fund Transactions - Certain General Fund expenditures are allocated to the Enterprise Fund. The allocation is based on time and effort for the benefit of the Enterprise Fund by General Fund employees. These allocated expenditures are reflected in the appropriate areas in the accompanying basic financial statements rather than as an inter-fund transaction. At September 30, 2014, the outstanding balance for both loans owed by the Enterprise Fund is $874,014. Refer to Note 8 for further detail about inter-fund transactions.

Pollution Remediation Obligations - The District has an environmental financial obligation for property purchased through September 30, 2014. Properties purchased during fiscal year 2014 were screened for potential environmental concerns based upon available records, assessments and other actions.

The assessments completed to date have found that most of these properties have a low to moderate risk. Currently, six properties, classified as low to moderate risk, have not been fully assessed to determine remediation requirements.

Based upon the Phase I, Phase II, or other site investigations completed to date, nine properties require remediation – eight of those are classified as high or moderate risk, while one is classified as low risk. The anticipated payment of $24.1 million for Pollution Remediation was capitalized on the eight properties that are near enough to the property acquisition date and meet the criteria for capitalization. Pollution remediation was begun on 7 properties, two of which were completed during Fiscal Year 2014. Total Pollution Remediation expenses during the year were $657,036.

Based upon the limited data available, any potential for a liability of the remediation of the remaining other properties cannot be reasonably estimated at this time.

Vacation and Sick Leave - The District's employees are granted paid leave in specified amounts. In the event of termination, an employee is reimbursed for all accumulated unused paid leave. Accrued paid leave is reflected in other liabilities in the accompanying basic financial statements. The change in accrued paid leave during the year is shown below:

	Balance at October 1, 2013	Additions	Deletions	Balance at September 30, 2014	Due Within One Year
Governmental Activities	$ 694,671	$ 199,946	$ 222,410	$ 672,207	$ 201,354
Business-type Activities	1,875,053	703,776	641,121	1,937,708	580,424
Total	$ 2,569,724	$ 903,722	$ 863,531	$ 2,609,915	$ 781,778

Water Revenues - Water rates charged to customers during each year are based on budgeted operating expenses, revenue bond debt service requirements, and estimated customer water usage. Subsequent to year-end, calculations of adjusted water rates based on actual usage and costs are made and either billed or credited to customer accounts as of year-end. While the actual results could differ from the estimate calculated, management normally does not expect the difference to be material to the financial statements. The calculated year-end adjustments for 2014 resulted in an estimated $536,994 due from the customers, which is reflected in the accounts payable balance in the Enterprise Fund. The District has not experienced any credit losses resulting from its sale of water.

Restricted Assets - Certain assets are classified as restricted assets, because their use is limited by applicable bond terms. These assets include amounts restricted for reserve and interest and sinking funds, as required by bond covenants. It also reflects unspent proceeds of revenue bonds.

Program Revenue-Contributions - During 2014 the District received no buy-in premiums for new customer water contracts.

Restricted Net Position - Restricted net position is the restricted assets less the related liabilities.

Budgets and Budgetary Accounting - Budgets are adopted on a basis consistent with accounting principles generally accepted in the United States of America. An annual budget by function is adopted for the General Fund.

Governmental Fund Balances –
Fund Balance Classification – The governmental fund financial statements present fund balances based on classifications that comprise a hierarchy that is based primarily on the extent to which the District is bound to honor constraints on the specific purposes for which amounts in the respective governmental funds can be spent. The classifications used in the governmental fund financial statements are as follows:

Non-Spendable fund balance - Assets that will never convert to cash, such as inventory and prepaid items. At September 30, 2014, the District had non-spendable fund balances in the amount of $3.7 million.

Restricted fund balance - The portion of fund balance that reflects resources that are subject to externally enforceable legal restrictions imposed by parties outside the District at September 30, 2014. At September 30, 2014, the District had no restricted fund balance.

Committed fund balance - The portion of fund balance that reflects resources that can be used only for specific purposes pursuant to constraints imposed by formal action of the Board of Directors. These amounts cannot be used for any other purpose unless the Board of Directors removes or changes the specified use by taking the same type of action (ordinance or resolution) that was employed when the funds were initially committed. At September 30, 2014 the District had no committed fund balance.

Assigned fund balance – The portion of fund balance that reflects resources intended for a specific purpose. Intent is expressed or authorized by Board of Directors.

Unassigned fund balance – The portion of fund balances in excess of non-spendable, restricted, committed, and assigned. This classification includes the residual fund balance for the General Fund of $111.9 million.

Spending Prioritization in Using Available Resources – When both restricted and unrestricted (i.e. committed, assigned, and unassigned) resources are available to be used for the same purpose, the District considers the restricted resources to be expended first. When all categories of unrestricted fund balance are available, the flow assumption is as follows: the committed resources get expended first, the assigned resources get expended second, and the unassigned resources get expended last.

Governmental Accounting Standards Board Statements Implemented in Current Fiscal Year – GASB 66, Technical Corrections; GASB 67, Financial Reporting for Pension Plans; and GASB 70, Accounting and Financial Reporting for Non-exchange Financial Guarantees were implemented with negligible effect on the District's financial statements.

2. REVENUES FROM THE SALE OF WATER

All revenues from the sale of water from Eagle Mountain Lake, Lake Bridgeport, Cedar Creek Lake, and Richland-Chambers Reservoir and related expenses are recorded in the Enterprise Fund.

Sales of water to four government entities (Cities of Fort Worth, Mansfield, and Arlington, and the Trinity River Authority of Texas) accounted for approximately 89% of the District's water sales for the year ended September 30, 2014. Charges to such entities are in amounts primarily equivalent to each entity's share (based on quantities of raw water received) of operating and maintenance costs and the debt service requirements of the District's revenue bonds.

3. CASH, CASH EQUIVALENTS, AND INVESTMENTS

The balance per bank of cash on deposit for the District and the TRVA at September 30, 2014 was $833,557 and $240,159 respectively, and was entirely covered by FDIC insurance or collateral. The carrying value of cash for the District and for TRVA was $791,049 and $228,898 respectively. At September 30, 2014 the District also held petty cash of $1,500.

Credit Risk - Legal provisions of the Texas Public Funds Investment Act generally permit the District to invest in direct and indirect obligations of the United States or its agencies, certain certificates of deposit, repurchase agreements, public funds investment pools, and money market mutual funds.

The District invests in the Texas Local Government Investment Pool ("Texpool"), the Local Government Investment Cooperative ("LOGIC") and Texas Short Term Asset Reserve ("TexSTAR"). Texpool, a public funds investment pool created by the Treasurer of the State of Texas acting by and through the Texas Treasury Safekeeping Trust Company, is empowered to invest funds and act as a custodian of investments purchased with local investment funds.

LOGIC and TexSTAR are also public funds investment pools with the same authority as Texpool. They have been organized and established pursuant to an Interlocal Agreement between participating government entities. The District has an undivided beneficial interest in the pool of assets held by these agencies. These investments and deposits are fully insured by the federal depository insurance or collateralized by securities held in the name of Texas Treasury Safekeeping Trust Company. Authorized investments include obligations of the United States or its agencies, direct obligations of the State of Texas or its agencies, certificates of deposits, and repurchase agreements.

Interest Rate Risk-As a means of limiting its exposure to fair value losses arising from interest rate fluctuations, the District's investment policy limits maturities based on the objectives of each fund. Investment maturities are limited as follows:

General Fund—one to three years

Enterprise Fund:
Revenue sub-fund—six months to one year
Construction sub-fund—determined on a project-by-project basis
Interest and Redemption sub-fund—six months
Reserve sub-fund—not to exceed the date of the District's last maturing revenue bond
Contingency sub-fund—one to three years

Concentration of Credit Risk-The District places no limit on the amount it may invest in one issuer. Approximately 56% of the District's investments are held in Federal Farm Credit Bank, Federal Home Loan Bank, Federal National Mortgage Association and Federal Home Loan Mortgage Corporation.

Custodial Credit Risk-The District's policy requires that all securities be held in the District's name.

Public Funds Investment Act – Audit procedures related to the Public Funds Investment Act are conducted as part of the audit of the basic financial statements disclosed that in the areas of investment practices, management reports and establishment of appropriate policies, the District adheres to the requirements of the Act.

Public Funds Collateral Act – Custodial credit risk is the risk that in the event of bank failure, the District's deposits may not be returned to it. The District has a policy of maintaining contact with the trust department of its depository agency to eliminate all custodial credit risk. As of September 30, 2014, the District's bank balance of $833,557 was not exposed to custodial credit risk and was over-insured and over-collateralized.

SUMMARY OF INVESTMENTS AND CASH EQUIVALENTS AND RELATED WEIGHTED AVG. MATURITY

	Fair Value **	Weighted Avg. Maturity (Years)	S & P Rating
Federal Farm Credit Bank	$ 125,814,581	1.81	AA+ ***
Federal Home Loan Bank	243,515,441	1.75	AA+ ***
Federal Home Loan Mortgage Corp	74,847,662	2.27	AA+ ***
Federal National Mortgage Association	39,328,554	2.39	AA+ ***
U.S. Treasury Notes	61,222,121	1.40	AA+ ***
	544,728,359		
Investment pools:*			
LOGIC****	98,171,461	N/A	AAA-m
TexPool	221,768,245	N/A	AAA-m
TexStar	159,785	N/A	AAA-m
Total investments and cash equivalents	$ 864,827,850		

*Local government pools operate as a money market fund under the Public Funds Investment Act, which requires that it maintain an AAA, AAA-m or equivalent rating from a nationally recognized rating service. Pools are rated AAA-m and operate in full compliance with the PFIA and rating agency requirements. The pools are exempted from SEC registration and the requirements of Rule 2a-7 pertaining to registered money market funds: however, consistent with Rule 2a-7, they seek to maintain a stable net position value of $1 per unit. Investment pools are reported as a part of cash and cash equivalents in the financial statements.

**Fair value is the amount at which a security could be exchanged in a current transaction between willing parties, other than in forced liquidation. Under GASB 31, all investments are recorded at fair value.

***On August 5, 2011 Standard and Poors, one of three nationally recognized raters of U.S. and government sponsored entities debt and securities, downgraded the rating of long-term U.S. sovereign debt from AAA to AA+ for the first time since 1941 with a negative outlook. The two other national raters, Moody's and Fitch, continue to have the highest ratings, but also have the debt on their watch lists.

**** Sandra Newby, Director of Finance, is a member of the LOGIC Board of Directors

4. CAPITAL ASSETS

A summary of changes in capital assets follows:

	October 1, 2013	Additions	Disposals	Transfers	September 30, 2014
GOVERNMENTAL ACTIVITIES					
NONDEPRECIABLE ASSETS					
Land	$ 141,387,171	$ 46,467,607	$ -	$ -	$ 187,854,778
Construction in progress	55,144,489	12,986,996	-	(9,171,360)	58,960,125
TOTAL NONDEPRECIABLE ASSETS	**196,531,660**	**59,454,603**	**-**	**(9,171,360)**	**246,814,903**
DEPRECIABLE ASSETS					
Dams, spillways, and related costs	3,378,736	-	-	-	3,378,736
Flood control projects	8,095,940	-	-	-	8,095,940
Buildings	25,361,800	-	-	9,171,360	34,533,160
Machinery and equipment	10,157,896	1,159,663	(161,829)	-	11,155,730
	46,994,372	1,159,663	(161,829)	9,171,360	57,163,566
Less accumulated depreciation for:					
Dams, spillways, and related costs	(608,937)	(84,198)	-	-	(693,135)
Flood control projects	(8,095,940)	-	-	-	(8,095,940)
Buildings	(6,229,084)	(1,232,119)	-	-	(7,461,203)
Machinery and equipment	(8,213,730)	(720,299)	158,338	-	(8,775,691)
	(23,147,691)	(2,036,616)	158,338	-	(25,025,969)
TOTAL DEPRECIABLE ASSETS, NET	**23,846,681**	**(876,953)**	**(3,491)**	**9,171,360**	**32,137,597**
CAPITAL LEASE DEPRECIABLE ASSETS					
Machinery and equipment	1,447,140	-	-	-	1,447,140
Less accumulated depreciation for:					
Machinery and equipment	(523,579)	(289,428)	-	-	(813,007)
	923,561	**(289,428)**	**-**	**-**	**634,133**
TOTAL GOVERNMENTAL ACTIVITIES, NET	**$ 221,301,902**	**$ 58,288,222**	**$ (3,491)**	**$ -**	**$ 279,586,633**

Depreciation expense was charged to functions of the District as follows:

Governmental activities:	
General government	$ 1,349,578
Flood Control	976,466
Total depreciation expense - governmental activities	$ 2,326,044

	October 1, 2013	Additions	Disposals	Transfers	September 30, 2014
BUSINESS-TYPE ACTIVITIES					
NONDEPRECIABLE ASSETS					
Land	$ 100,739,236	$ 33,044,957	$ (1,000)	$ -	$ 133,783,193
Construction in progress	294,255,165	133,587,472	-	(64,043,379)	363,799,258
TOTAL NONDEPRECIABLE ASSETS	**394,994,401**	**166,632,429**	**(1,000)**	**(64,043,379)**	**497,582,451**
DEPRECIABLE ASSETS					
Dams, spillways, and related costs	210,382,594	-	-	2,547,045	212,929,639
Pipeline and pipeline right of way	507,235,559	-	-	3,055,321	510,290,880
Wetlands	8,823,497	-	-	45,268,105	54,091,602
Communications	1,087,448	-	-	-	1,087,448
Buildings	6,769,080	-	-	47,507	6,816,587
Machinery and equipment	12,714,871	552,134	(344,611)	-	12,922,394
Other project costs	47,648,525	4,322,084	-	13,125,401	65,096,010
	794,661,574	4,874,218	(344,611)	64,043,379	863,234,560
Less accumulated depreciation for:					
Dams, spillways, and related costs	(104,362,228)	(4,146,337)			(108,508,565)
Pipeline and pipeline right of way	(154,103,799)	(9,890,711)			(163,994,510)
Wetlands	(1,814,143)	(169,117)			(1,983,260)
Communications	(221,813)	(20,664)			(242,477)
Buildings	(3,702,635)	(251,973)			(3,954,608)
Machinery and equipment	(10,860,446)	(829,666)	334,941		(11,355,171)
Other project costs	(6,922,879)	(1,050,428)			(7,973,307)
Total accumulated depreciation	(281,987,943)	(16,358,896)	334,941	-	(298,011,898)
TOTAL DEPRECIABLE ASSETS, NET	**512,673,631**	**(11,484,678)**	**(9,670)**	**64,043,379**	**565,222,662**
INTANGIBLE ASSETS					
Water Rights	2,086,598				2,086,598
Less accumulated depreciation for:					
Water Rights	(1,524,375)	(69,553)			(1,593,928)
	562,223	**(69,553)**	**-**	**-**	**492,670**
TOTAL BUSINESS-TYPE ACTIVITIES, NET	**$ 908,230,255**	**$ 155,078,198**	**$ (10,670)**	**$ 0**	**$ 1,063,297,783**

5. PENSION PLAN

Plan Description and Provisions - In 1997, the District adopted a defined contribution benefit plan, the benefits of which depend solely on amounts contributed to the plan plus investment earnings. All full-time employees over the age of 18 are eligible to participate in the plan from the date of employment, and benefits are fully vested at five years of service. Benefit provisions and all other requirements are established by state statute and the District's Board of Directors. The District contributes 13% of each eligible employee's base salary on a monthly basis to the plan's Administrator, ICMA Retirement Trust. Employees may make additional voluntary after tax contributions; however, no employees have contributed to date. District contributions for, and interest forfeited by, employees who leave employment before five years of service are allocated to the other employee accounts. The plan's normal retirement age is 60 years with early retirement eligibility at 55 years of age with five years of service. During 2014 the District made contributions of $2,054,437 under this plan.

6. BONDS PAYABLE

A summary of long-term debt transactions (excluding original issue premiums) of the District for the year ended September 30, 2014 is show below. Bond issuance costs of $3.7 million were expensed this year.

	Balance at October 1, 2013	Additions	Deletions	Balance at September 30, 2014	Due Within One Year
Business-type Activities--- Enterprise Funds-Revenue	$ 802,235,000	$ 520,880,000	$ 30,310,000	$ 1,292,805,000	$ 37,155,000

Bonds Payable-In Fiscal Year 2014, the District issued $318.75 million of Water Revenue Bonds and $202.13 million of Contract Revenue Bonds with Dallas Water Utilities.

Bond Type	Maturity	Interest Rates	Outstanding Balance
Tarrant Regional Water District Projects			
$182,905,000 Series 2006 Water Revenue Bonds	Serially through 2029	4.2 - 5.0%	$182,905,000
$3,135,000 Series 2008A-RC Water Revenue Bonds	Serially through 2027	1.3 - 2.8%	2,770,000
$6,755,000 Series 2008B-CC Water Revenue Bonds	Serially through 2027	2.0 - 2.8%	4,375,000
$69,535,000 Series 2009 Water Revenue Refunding and Improvement Bonds	Serially through 2029	5%	53,845,000
$89,250,000 Series 2010 Water Revenue Bonds	Serially through 2040	4.0 - 5.0%	89,250,000
$17,835,000 Series 2010A Water Revenue Bonds	Serially through 2030	1.2 - 2.6%	17,835,000
$83,785,000 Series 2010B Water Revenue Bonds	Serially through 2030	1.0 - 2.5%	70,790,000
$150,375,000 Series 2012 Water Revenue Bonds	Serially through 2052	2.0 - 5.0%	144,990,000
$98,960,000 Series 2012A Water Revenue Refunding Bonds	Serially through 2022	2.0 - 5.0%	78,690,000
$318,750,000 Series 2014 Water Revenue Bonds	Serially through 2049	4.0 - 5.0%	318,750,000
			964,200,000
TRWD Contract Revenue Bonds (City of Dallas Project)			
$131,935,000 Series 2012 Dallas Contract Revenue Bonds	Serially through 2042	2.0 - 5.0%	126,475,000
$202,130,000 Series 2014 Dallas Contract Revenue Bonds	Serially through 2044	4.0 - 6.0%	202,130,000
			328,605,000
Total-Constuction and Improvement Bonds			1,292,805,000
Less current portion			(37,155,000)
Add premium (net of accumulated amortization)			88,080,004
			$1,343,730,004

In prior years, the District defeased certain revenue and refunding bonds by placing the proceeds of new bonds in an irrevocable trust to provide for all future debt service payments on the old bonds. Accordingly, the trust account assets and the liability for the defeased bonds are not included in the District's financial statements. At September 30, 2014 there are no bonds outstanding that are considered defeased, as all future maturities have been called.

The District amortizes deferred amounts on refunding, including gains and losses, using the straight-line method over the shorter of the remaining life of the old debt or the life of new debt. Premiums on bonds are amortized using the effective interest rate method over the life of the bonds.

The annual requirements to amortize all bonds outstanding as of September 30, 2014 including interest payments are approximately as follows:

Years ending September 30th (in thousands)	Principal	Interest	Requirements
Tarrant Regional Water District Projects			
2015	$ 31,280	$ 42,908	$ 74,188
2016	30,185	41,557	71,742
2017	30,975	40,195	71,170
2018	24,105	39,421	63,526
2019	25,820	38,625	64,445
2020-2024	146,495	176,765	323,260
2025-2029	177,530	142,692	320,222
2030-2034	161,245	103,842	265,087
2035-2039	104,310	69,909	174,219
2040-2044	93,160	46,649	139,809
2045-2049	117,010	20,739	137,749
2050-2054	22,085	1,693	23,778
	964,200	764,995	1,729,195
TRWD Contract Revenue Bonds (City of Dallas Project)			
2015	5,875	15,347	21,222
2016	6,090	15,051	21,141
2017	6,310	14,715	21,025
2018	6,535	14,365	20,900
2019	6,775	14,003	20,778
2020-2024	37,925	64,089	102,014
2025-2029	47,005	54,067	101,072
2030-2034	58,935	43,485	102,420
2035-2039	74,875	28,686	103,561
2040-2044	78,280	10,076	88,356
	328,605	273,884	602,489
Total	$ 1,292,805	$ 1,038,879	$ 2,331,684

Bonded debt of the District consists of water revenue refunding bonds and revenue bonds, which are secured by and payable from net revenues of the District. Certain revenue bond issues contain provisions that allow the District to prepay or call the bonds.

Specifically, net revenues of the District's water operations have been pledged for repayment of the District's revenue bonds. The amount of the pledge is equal to the remaining outstanding debt service requirements for those bonds, which were all originally issued to provide funding for construction of the water system. The pledge continues for the life of the bonds. For the year ended September 30, 2014, pledged revenues for the enterprise fund were $49,181,265.

The various revenue bond indentures contain significant limitations and restrictions on annual debt service requirements, maintenance of and flow of monies through various restricted accounts, and minimum amounts to be maintained in various sinking funds. None of the revenue bond indentures contain bond coverage requirement provisions.

The TRWD Contract Revenue Bonds (City of Dallas Project) are Dallas Water Utilities share of the Integrated Pipeline (IPL) Project, which is currently estimated at $936 million. Under the IPL Project Contract, Dallas has requested and authorized the District to issue contract revenue bonds (the "Dallas Contract Revenue Bonds") secured solely by payments from Dallas to the District under the IPL Project Contract. Such Dallas Contract Revenue Bonds shall be in such amounts and issued at such times as determined by the District, in consultation with Dallas to finance Dallas's share of the design and construction of the IPL project. All such payments by Dallas to the District will constitute operating expenses of the Dallas Water Utilities System. It is currently expected that the District will issue Dallas Contract Revenue Bonds over a 10 to 15 year period to pay Dallas's share of the total capital cost of the IPL project. The District issued the first series of Dallas Contract Revenue Bonds in the principal amount of $131.9 million in February 2012, and the second series of Dallas Contract Revenue bonds in the principal amount of $202.1 million in January 2014. Future Dallas Contract Revenue Bonds will be issued as determined by the District in consultation with Dallas; provided, however, the IPL Project Contract gives the District specific authority to issue Dallas Contract Revenue Bonds without any additional City approval in the event Dallas fails to take certain actions. Dallas's interest in the IPL is not part of the District's System and none of the payments from Dallas to the District under the IPL Project Contract are pledged to the payment of the District's System Revenue Bonds.

7. CAPITAL LEASES

Obligations under a capital lease represent the remaining principal amounts under lease purchase agreements for the acquisition of various computer equipment. These leases are recorded as capital leases in the government-wide reporting. Amortization of the leased assets is included in depreciation expenditures in the government-wide reporting. The leased equipment had an original cost totaling $1.5 million in the General Fund, and $1.2 million in the Enterprise Fund.

The following is a summary of capital lease transactions of the District for the year ended September 30, 2014:

	General Fund	Enterprise Fund
Capital lease obligations, October 1, 2013	$ 735,324	$ 51,616
Less: Principal payments	(246,941)	(51,616)
Add: New Leases	-	-
Capital lease obligations, September 30, 2014	$ 488,383	$ -

The following schedule provides an analysis of the District's investment in capital assets under lease arrangements as of September 30, 2014:

	General Fund	Enterprise Fund
Capital Lease	$ 1,447,140	$ 1,179,654
Less: Accumulated depreciation	(813,007)	(1,047,712)
Total net book value of lease assets	$ 634,133	$ 131,942

Future minimum lease payments for these leases are as follows:

	General Fund		Enterprise Funds	
Year Ending September 30,	Principal Payments	Interest Payments	Principal Payments	Interest Payments
2015	$ 239,242	$ 20,208	$ -	$ -
2016	249,141	10,309	-	-
	$ 488,383	$ 30,517	$ -	$ -

8. INTER-FUND TRANSACTIONS

At September 30, 2014 inter-fund balances consisted of the following:

	Notes & Interest Due From Other Funds	Notes & Interest Due to Other Funds	Due From Other Funds	Due to Other Funds
General Fund	$ 874,014		$ 8,538,375	
Enterprise Fund		$ 874,014		$ 8,538,375
Total	$ 874,014	$ 874,014	$ 8,538,375	$ 8,538,375

The District has two notes between the Enterprise Fund and the General Fund for the reimbursement of a portion of the cost of constructing the administrative building, and the purchase of a helicopter. The administrative building note was set up in 2003; the helicopter note was set up in 2009. During fiscal year 2014, the Enterprise fund repaid $100,471, plus interest of $27,097. At September 30, 2014, the outstanding balance for both loans owed by the Enterprise Fund is $874,014 which is related to its Long-term payable to the General Fund. In the fund financial statements, inter-fund balances (shown as due to/from other funds) are the results of normal expenditure transactions between funds and will be liquidated in the subsequent fiscal year.

All inter-fund receivables and payables are combined in the government-wide financial statement of net position and shown as internal balances.

9. POST EMPLOYMENT HEALTH CARE BENEFITS

Plan Descriptions

The District provides post-employment health care benefits, as established under its Retiree Health Benefits Policy (policy dated January 17, 2006). All retirees who retired prior to the January 1, 2006 policy implementation met the following requirements to continue the health care benefits. The District provides post-retirement health care benefits to all employees who retire from the District at age 55 or after with at least 10 years of continuous full-time employment immediately preceding retirement (and meets the Rule of 80 or Rule of 90). Retirees must also pay a portion (approximately 6%) of the required premiums to carry coverage. During Fiscal Year 2014, twenty-one retirees meet those eligibility requirements and participate in the program. Once an employee or dependent reaches 65 the retiree is eligible for Medicare and the post-employment health care benefits are no longer in effect. The retirees' spouse can continue the post-employment health care benefits for an additional five years after the retiree reaches 65 or until the spouse turns 65, whichever occurs first. The cost of these benefits is recognized as expenditures when the underlying claims or premiums are incurred. During the year ended September 30, 2014, payments of $1,348,797 were recognized for post-retirement health care.

Effective January 1, 2006, Group Health Insurance premiums for retirees are based on the "Rule of 80" or the "Rule of 90". These rules also apply in the event of disability or death while in service.

Rule of 80—the rule of 80 is reached when age and years of service total eighty (80).

If at the time of retirement, the employee meets the "Rule of 80" and elects to continue group health insurance coverage, the District will pay 100% for the premiums for the employee/retiree, the spouse and eligible dependents at the date of retirement. After the initial election, coverage for individuals may be dropped at the time designated by the plan, but no one may be added.

Upon the death of the employee/retiree, the spouse will be covered for an additional five (5) years or until their death, whichever occurs first. Any dependent will be covered as long as they remain eligible under the plan, for five years, or death, whichever comes first.

Rule of 90—the rule of 90 is reached when age and years of service total ninety (90).

If at the time of retirement, the employee meets the "Rule of 90" and elects to continue group health insurance coverage; the District will pay 100% for the single and family premiums for the employee/retiree, the spouse and eligible dependents at the date of retirement. The employee/retiree will be covered until his/her death and the spouse until his/her death, and the

eligible dependents will be covered as long as eligible under the plan or their death, whichever comes first.

All retirees who retired prior to January 1, 2006, and are currently continuing group health insurance coverage through the District will be grand-fathered from this change in policy and will continue paying a flat rate for premiums until their coverage terminates.

While the District does offer this plan to all eligible employees, some retirees elect not to continue the health coverage during their retirement. During Fiscal Year 2014, twenty-one retirees and beneficiaries meet those eligibility requirements. Employees that retired prior to the effective date are not eligible to receive these benefits.

Funding Policies

For other postemployment benefits, contractual requirements for the District are established by the Board of Directors. In Fiscal Year 2014, the District established a trust to fund OPEB costs through Public Agency Retirement Fund (PARS). The District funded the trust with an initial $1 million transfer. In Fiscal Year 2015, another $1 million is budgeted to continue funding the trust. The District continues to pay for a major portion of all of the total health insurance premiums for retirees depending on the retiree's date of employment or length of service and on the retiree's coverage election.

Blended Rate Scenario

The District has established an irrevocable trust and has adopted a funding policy so that the amounts contributed are less than the funding ARC. Under this scenario, GASB 45 requires the use of a discount rate based on a blend of the plan and employer assets. For this valuation, a blended discount rate of 6.20% is assumed. In fiscal year ending September 30, 2014, TRWD contributed $1,000,000 to the OPEB trust. An OPEB trust contribution of $1,663,070 would have satisfied the full funding ARC. Because the additional contribution was 60% of amount required to satisfy the full funding ARC, a blended discount rate based on 60% of the difference between 4.50% and 7.30% was chosen. This blended discount rate has caused a $10.4 million decrease in the Actuarial Accrued Liability (AAL) estimate over what the AAL would have been using the old 4.50% discount rate.

Annual OPEB Costs

The District's annual other post-employment benefits (OPEB) cost is calculated based on the annual required contribution of the employer (ARC), an amount actuarially determined in accordance with the parameter of GASB Statement No. 45. The ARC represents a level of accrual that is projected to recognize the normal cost each year and to amortize any unfunded actuarial liabilities (or funding excess) over a period not to exceed thirty years. The annual OPEB cost for the fiscal year ended September 30, 2014, is as follows:

	2013	2014
Annual required contribution	$ 2,778,216	$ 2,234,270
Interest on OPEB obligation	292,592	545,458
Adjustment to ARC	(271,084)	(454,767)
Annual OPEB cost (expense)	2,799,724	2,324,961
Contributions made	(504,072)	(1,348,750)
Increase in net OPEB obligation	2,295,652	976,211
Net OPEB obligation--as of beginning of the year	6,502,051	8,797,703
Net OPEB obligation--as of end of year	$ 8,797,703	$ 9,773,914
Percentage of annual OPEB cost contributed	18.0%	58.0%

At September 30, 2014, the total liability of $9,773,914 for Net OPEB obligation was $3,319,110 for governmental activities and $6,454,804 for business-type activities.

The District's annual OPEB cost, the percentage of annual OPEB cost contributed to the plan, and the net OPEB obligation for the past three years follows:

Fiscal Year Ended	Annual OPEB Cost	Employer Contribution	Annual OPEB Cost Contributed	Net OPEB Obligation
9/30/2012	$ 2,239,521	$ 525,879	23.5%	$ 6,502,051
9/30/2013	$ 2,799,724	$ 504,072	18.0%	$ 8,797,703
9/30/2014	$ 2,324,961	$1,348,750	58.0%	$ 9,773,914

Funding Status and Funding Progress

The funded status of the District's retiree health care plan, under GASB Statement No. 45 as of December 31, 2011 is as follows:

Actuarial accrued liability (a)	$	28,791,154
Actuarial value of plan assets (b)		-
Unfunded actuarial accrued liability (a-b)		28,791,154
Funded ratio (b) / (a)		0%
Covered payroll (c)	$	13,624,301
Unfunded actuarial accrued liability as a percentage of covered payroll ((a – b) / c)		211%

Under the reporting parameters, as of December 31, 2011 the District's retiree health care plan was 0.0% funded with an estimated actuarial accrued liability exceeding actuarial assets by $28,791,154. The ratio of the unfunded actuarial accrued liability to annual covered payroll was 211%.

Actuarial Methods and Assumptions

The Entry Age Normal actuarial cost method is used to calculate the GASB ARC for the District's retiree health care plan. Using the plan benefits, the present health premiums and a set of actuarial assumptions, the anticipated future payments are projected. The entry age normal method then provides for a systematic recognition of the cost of these anticipated payments. The yearly ARC is computed to cover the cost of benefits being earned by covered members as well as to amortize a portion of the unfunded accrued liability.

Projections of health benefits are based on the plan as understood by the District and include the types of benefits in force at the valuation date and the pattern of sharing benefit costs between the District and its employees to that point. Actuarial calculations reflect a long-term perspective and employ methods and assumptions that are designed to reduce short-term volatility in actuarial accrued liabilities and the actuarial value of assets. Significant methods and assumptions were as follows:

Actuarial Methods and Assumptions

Inflation rate	3.0% per annum
Investment rate of return	6.2%, net of expenses
Actuarial Cost Method	Entry Age Normal Cost Method
Amortization method	Level as a Percentage of Employee Payroll
Amortization period	30-year Open Amortization
Payroll Growth	3.0% per annum
Healthcare Cost Trend Rate	Initial Rate of 8.5% Declining to an Ultimate Rate of 4.5% after 8 years

Actuarial valuations involve estimates of the value of reported amounts and assumptions about the probability of events in the future. Amounts determined regarding the funded status and the annual required contributions of the District's retiree health care plan are subject to continual revision as actual results are compared to past expectations and new estimates are made about the future. The required schedule of funding progress presented as required supplementary information provides multiyear trend information that shows whether the actuarial value of plan assets is increasing or decreasing over time relative to the actuarial accrued liability for benefits.

10. COMMITMENTS AND CONTINGENCIES

Commitments-the Enterprise and General Fund have remaining commitments estimated at $135.1 million ($131.7 million and $3.4 million respectively) due to on-going construction contracts as of September 30, 2014.

Contingent Liabilities - The District is involved in lawsuits arising in the ordinary course of business, including claims involving water and mineral rights, contract disputes, and alleged property damages. Certain amounts have been accrued for potential losses. It is management's opinion that outstanding claims would not have a material effect on the District's operations.

Insurance - The District has employee blanket bond insurance. The District also participates in a public entity risk pool for its fleet policy, property insurance, workers' compensation, general liability, and director/officer liability coverage. For the IPL project the District, along with the City of Dallas, is utilizing a Rolling Owner Controlled Insurance Program (ROCIP).

For the public entity risk pool, in the event of an occurrence, wrongful act, or personal injury, written notice containing particulars of the incident or injury shall be promptly provided to the Texas Water Conservation Association Risk Management Fund (the "Trust"). If a claim is made or a suit is brought against the District, the District shall immediately forward to the Trust every demand, notice, summons, or other process received. The District shall cooperate with the Trust and give any information as may be reasonably required, and upon the Trust's request, assist in making settlement, in the conduct of suits and in enforcing any right of contribution or indemnity against any person or organization who may be liable to the District because of injury or damage with respect to which insurance is afforded under the agreement. The District shall attend hearings and trials and assist in securing and giving evidence and obtaining the attendance of witnesses. The District shall not, except at its own cost, voluntarily make any payment, assume any obligation, or incur any expense that could increase the liability, exposure of, or jeopardize the Trust in any way.

The Trust will pay on behalf of the District all sums that the District shall become legally obligated to pay arising out of an occurrence that takes place during the Trust year and within the agreement. The Trust reserves the right to deny any and all claims that are not reported.

The Trust shall have the right and the duty to defend any suit against the District, even if the allegations of the suit are groundless, false or fraudulent, and may make such investigation and settlement of any claim or suit it deems expedient, but the Trust shall not be obliged to pay any claim or judgment, or to defend a suit, after the applicable limit of the Trust's liability has been exhausted.

Any settlement amounts paid within the past three years have not exceeded the District's insurance coverage.

The IPL Rolling Owner Controlled Insurance Program (ROCIP) program is a master insurance, safety, and claims management program that provides specific coverages for Workers' Compensation, Employers Liability, Commercial General Liability, and Excess Liability for the Owner and all Enrolled Participants on the IPL.

In the event of an occurrence, wrongful act, or personal injury, all participants in the ROCIP program must promptly provide written notice to Willis of Texas, the ROCIP Administrator, per contract agreement. The ROCIP Administrator will check the information for accuracy and promptly report the claim to the Insurance Provider. The Insurance Provider will coordinate the investigation of commercial general liability claims. Contractor's team members are required to cooperate with the Insurance Provider's investigations. A per occurrence deductible of $5,000 will be paid by the enrolled participant.

Notifications of a lawsuit or litigation are made to the PCM and ROCIP Administrator and shall be by email or telephone immediately when served with notice of any lawsuits or citations filed against either Enrolled Participants or Excluded Participants. Failure to respond to a lawsuit within the prescribed time may result in a default judgment. The entity served with the lawsuit will pay judgments and expenses associated with a default judgment. Enrolled participants must initially report all workers' compensation claims to the ROCIP Administrator. Claims must be reported no later than the end of the shift during which the accident occurred except in cases of serious injuries which shall be reported immediately. The Insurance Provider will coordinate the investigations of all workers' compensation claims.

The ROCIP provides builders risk coverage for all enrolled participants. The coverage includes all materials and equipment that will be permanently incorporated into the project including property in-transit and stored at pre-approved locations. Enrolled participants are responsible for the first $25,000 of any loss.

At this time there are no losses to report.

Arbitrage Rebate Liability - The excess profit earned from investing the proceeds of tax-exempt bonds at a yield that is materially higher than the yield on the bonds. Excess earnings are required to be rebated every five years or upon maturity of the bonds, whichever is earlier. The District has no arbitrage rebate liability as of September 30, 2014.

11. RECENTLY ISSUED GASB STATEMENTS

The GASB has issued a number of standards that will become effective for the District in future years.

GASB Statement No. 68: Accounting and Financial Reporting for Pensions - was also issued in June 2012 and establishes accounting and financial reporting requirements related to pensions for governments whose employees are provided with pensions through pension plans, as well as for nonemployer governments that have a legal obligation to contribute to those plans. This statement requires the recognition of the entire net pension liability and a more comprehensive measure of pension expense, along with additional required footnote disclosures. This standard becomes effective for the District in fiscal year 2015 but is not applicable to the District practices.

GASB Statement No. 69: Government Combinations and Disposals of Government Operations - was issued in January 2013 and establishes accounting and financial reporting standards for government combinations and disposals of government operations. This statement distinguishes between government mergers and acquisitions and provides guidance on the appropriate accounting treatment of each. This Statement also provides guidance for transfers of operations that do not constitute entire legally separate entities and in which no significant consideration is exchanged. GASB 69 becomes for the District in fiscal year 2015, and should be applied on a prospective basis.

GASB Statement No. 71: Pension Transition for Contributions Made Subsequent to the Measurement Date—an amendment of GASB Statement No. 68 - was issued in November 2013 and addresses the transition provisions of GASB Statement No. 68, *Accounting and Financial Reporting for Pensions*. GASB 71 eliminates a potential source of understatement of restated beginning net position and expense in a government's first year of implementing GASB Statement No. 68. This statement becomes effective for the District in fiscal year 2015.

COMPONENT UNIT

The following notes are for the District's component unit, Trinity River Vision Authority, which are not duplicated by the notes of the District.

12. SUMMARY OF SIGNIFICANT ACCOUNTING POLICIES FOR TRVA

Reporting Entity - by resolution dated July 18, 2006, the Board of Directors of the Tarrant Regional Water District (the "District") authorized the incorporation of the Trinity River Vision Authority (TRVA). Subsequently, TRVA was incorporated by the Texas Secretary of State on July 21, 2006 and is governed, in part, by the Texas Development Corporation Act of 1979 (the "Act"). The TRVA is authorized to act on behalf of the District and the District's authority and instrumentality for the public purposes of educating the general public regarding the **Trinity River Vision Project** in Fort Worth, Texas, publishing educational materials about said Project, assisting in the coordination and implementation of the Project, and performing such other activities and purposes as permitted by applicable law or authorized by the Board of Directors of TRVA.

The accounting policies of the TRVA conform to accounting principles generally accepted in the United States of America as applicable to governmental units and promulgated by the Governmental Accounting Standards Board (GASB). The following is a summary of the more significant policies.

Financial Reporting Entity-TRVA is included as a discrete component unit in the financial statements of the District.

Cash and Cash Equivalents-cash and cash equivalents are considered to be cash on hand, demand deposits and short-term investments with maturities of three months or less. Cash and cash equivalents for fiscal year 2014 cash and cash equivalents consist of deposits (principally interest-bearing accounts) with one financial institution and in a public funds investment pool.

Capital Assets-capital assets of TRVA are transferred to the District or the City of Forth Worth upon completion. Construction in Progress is recorded for any capital assets not completed as of year-end.

Budgets and Budgetary Accounting-budgets are adopted on a basis consistent with accounting principles generally accepted in the United States of America. An annual budget is adopted for the General Fund.

13. CASH AND CASH EQUIVALENTS FOR TRVA

The balance per bank of cash on deposit at September 30, 2014 was $240,159 and was entirely covered by FDIC insurance. The carrying value for TRVA was $228,898 as of September 30, 2014.

Legal provisions generally permit TRVA to invest in direct and indirect obligations of the United States or its agencies, certain certificates of deposit, repurchase agreements, public funds investment pools, and mutual funds. During the year ended September 30, 2014, TRVA did not own any types of securities other than those permitted by statute. The TRVA invests in the Texas Local Government Investment Pool ("TexPool"). TexPool is a public fund investment pool created by the Treasurer of the State of Texas acting by and through the Texas Treasury Safekeeping Trust Company, is empowered to invest funds and act as a custodian of investments purchased with local investment funds. It has been organized and established pursuant to an Interlocal Agreement between participating government entities. TRVA has an undivided beneficial interest in the pool of assets held by this agency. These investments and deposits are fully insured by federal depository insurance or collateralized by securities held in the name of Texas Treasury Safekeeping Company, the entity that created TexPool. Authorized investments include obligations of the United States or its agencies, direct obligations of the State of Texas or its agencies (TexPool only), certificates of deposit, and repurchase agreements. TRVA's balance in TexPool as of September 30, 2014 was $2.7 million.

Interest Rate Risk-as a means of limiting its exposure to fair value losses arising from interest rate fluctuations, TRVA's investment policy limits maturities to a maximum of three years.

Concentration of Credit Risk-TRVA places no limit on the amount the TRVA may invest in one issuer. All investments at September 30, 2014 were in TexPool.

Custodial Credit Risk-TRVA policy requires that all securities be held in TRVA's name.

SUMMARY OF INVESTMENTS AND RELATED WEIGHTED AVERAGE MATURITY

	Fair Value **	Weighted Avg. Maturity (Years)	S & P Rating
Investment Pools*			
Texpool	$ 2,707,322	N/A	AAA-m
Total investments	$ 2,707,322		

*Local government pools operate as a money market fund under the Public Funds Investment Act, which requires that it maintain an AAA, AAA-m or equivalent rating from a nationally recognized rating service. Pools are rated AAA-m and operate in full compliance with the PFIA and rating agency requirements. The pools are exempted from SEC registration pertaining to registered money market funds; however, they seek to maintain a stable net position value of $1 per unit.

**Fair value is the amount at which a security could be exchanged in a current transaction between willing parties, other than in forced liquidation. All investments are recorded at fair value.

14. CAPITAL ASSETS FOR TRVA

A summary of changes in capital assets follows:

	October 1, 2013	Additions	Disposals	Transfers	September 30, 2014
Construction in progress	$ 1,660,976	$ 4,161	$ (1,665,137)	$ -	$ -
TOTAL NONDEPRECIABLE ASSETS	**1,660,976**	**4,161**	(1,665,137)	-	-
TOTAL CAPITAL ASSETS	**$ 1,660,976**	**$ 4,161**	**$ (1,665,137)**	**$ -**	**$ -**

Upon completion of the design phase of the White Settlement Bridge and local street modifications, the asset was contributed to the Texas Department of Transportation.

15. COMMITMENTS AND CONTINGENCIES FOR TRVA

Insurance-the TRVA has employee blanket bond insurance. The TRVA also participates in a public entity risk pool for its general liability, automotive reliability, and errors and omissions liability coverage. The TRVA has such insurance coverage as an additional insured on a policy issued to the Tarrant Regional Water District through the Texas Water Conservation Association Risk Management Fund (the "Trust"). The general policy conditions provide as follows:

In the event of an occurrence, wrongful act, or personal injury, written notice containing particulars of the incident or injury shall be promptly provided to the Trust. If a claim is made or a suit is brought against the TRVA, the TRVA shall immediately forward to the Trust every demand, notice, summons, or other processes received. TRVA shall cooperate with the Trust and give any information as may be reasonably required, and upon the Trust's request, assist in making settlement, in the conduct of suits and in enforcing any right of contribution or indemnity against any person or organization who may be liable to the TRVA because of injury or damage with respect to which insurance is afforded under the agreement. The TRVA shall attend hearings and trials and assist in securing and giving evidence and obtaining the attendance of witnesses. The TRVA shall not, except at its own cost, voluntarily make any payment, assume any obligation, or incur any expense that could increase the liability exposure of, or jeopardize the Trust in any way.

The Trust will pay on behalf of the TRVA all sums that TRVA shall become legally obligated to pay arising out of an occurrence that takes place during the Trust year and within the agreement. The Trust reserves the right to deny any and all claims that are not reported. The Trust shall have the right and the duty to defend any suit against the TRVA, even if the allegations of the suit are groundless, false or fraudulent, and may make such investigation and settlement of any claim or suit it deems expedient, but the Trust shall not be obligated to pay any claim or

judgment, or to defend a suit, after the applicable limit of the Trust's liability has been exhausted.

As of September 30, 2014, there were no settlements paid from the insurance coverage on behalf of the TRVA.

REQUIRED SUPPLEMENTARY INFORMATION (UNAUDITED)

TARRANT REGIONAL WATER DISTRICT

SCHEDULE OF REVENUES, EXPENDITURES, AND CHANGES IN FUND BALANCE—BUDGET TO ACTUAL—GAAP BASIS—GENERAL FUND (UNAUDITED)
FOR THE YEAR ENDED SEPTEMBER 30, 2014

	Original and Final Budget	Actual
REVENUES:		
Property taxes	$ 8,600,000	$ 9,263,039
Lease rentals	1,266,200	1,314,725
Oil and gas royalties	20,000,000	24,518,478
Sale of rock and gravel	12,500	12,500
Investment income	575,000	367,655
Contributions	300,000	3,386,255
Other	145,300	311,573
Total revenues	30,899,000	39,174,225
EXPENDITURES		
Current:		
General and administrative	9,608,964	9,043,006
Personnel services	4,984,379	4,821,935
Pension plan contribution	571,765	512,818
Contributions to component unit	40,000	18,434,944
Capital expenditures	65,200,000	39,365,013
Capital lease payment	278,000	277,377
Total expenditures	80,683,108	72,455,093
CHANGE IN FUND BALANCE	(49,784,108)	(33,280,868)
FUND BALANCE—Beginning of year	148,953,824	148,953,824
FUND BALANCE—End of year	$ 99,169,716	$ 115,672,956

Note to RSI

Excess of Contributions to Component Unit over Budget - for year ended September 30, 2014, the $18.4 million contribution made to TxDOT related to the construction of the three bridges was not budgeted for in the Contributions to Component Unit line item.

TARRANT REGIONAL WATER DISTRICT
SCHEDULE OF FUNDING PROGRESS AND EMPLOYER CONTRIBUTIONS
OTHER POSTEMPLOYMENT BENEFITS (UNAUDITED)
FOR THE YEAR ENDED SEPTEMBER 30, 2014

Valuation Date	Actuarial Value of Assets (AVA)	Actuarial Accrued Liability (AAL)	Unfunded Actuarial Accrued Liability (UAAL)	Funded Ratio	Annual Covered Payroll	UAAL as % of Payroll
	(a)	**(b)**	**(b-a)**	**(a/b)**	**(c)**	**((b-a)/c)**
12/31/2007	$ -	$ 25,092,209	$ 25,092,209	0%	$ 9,372,400	268%
12/31/2009	$ -	$ 31,676,995	$ 31,676,995	0%	$ 11,489,400	276%
12/31/2011	$ -	$ 39,215,923	$ 39,215,923	0%	$ 13,624,301	288%
12/31/2011*	$ -	$ 28,791,154	$ 28,791,154	0%	$ 13,624,301	211%

* The recalculated 12/31/2011 AAL reflects a change in the discout rate from 4.50% to 6.20%.

OTHER SUPPLEMENTARY INFORMATION (UNAUDITED)

TARRANT REGIONAL WATER DISTRICT

SCHEDULE OF BONDS AUTHORIZED, ISSUED, AND OUTSTANDING BY PURPOSE OF ISSUE
AS OF SEPTEMBER 30, 2014 (UNAUDITED)

	Year Authorized	Issued Amount	Outstanding
Construction and improvement bonds:			
Tarrant Regional Water District Projects			
Water Revenue Bonds - Series 2006	2006	$ 182,905,000	$ 182,905,000
Water Revenue Bonds - Series 2008A-RC	2008A	3,135,000	2,770,000
Water Revenue Bonds - Series 2008B-CC	2008B	6,755,000	4,375,000
Water Revenue Refunding and Improvement Bond - Series 2009	2009	69,535,000	53,845,000
Water Revenue Bonds - Series 2010	2010	89,250,000	89,250,000
Water Revenue Bonds - Series 2010A	2010	17,835,000	17,835,000
Water Revenue Bonds - Series 2010B	2010	83,785,000	70,790,000
Water Revenue Bonds - Series 2012	2012	150,375,000	144,990,000
Water Revenue Refunding Bonds - Series 2012A	2013	98,960,000	78,690,000
Water Revenue Bonds - Series 2014	2014	318,750,000	318,750,000
		1,021,285,000	964,200,000
TRWD Contract Revenue Bonds (City of Dallas Project)			
Contract Revenue Bonds (City of Dallas Project) - Series 2012	2012	131,935,000	126,475,000
Contract Revenue Bonds (City of Dallas Project) - Series 2014	2014	202,130,000	202,130,000
		334,065,000	328,605,000
Total - Construction and improvement bonds		$ 1,355,350,000	$ 1,292,805,000

Note: Above amounts exclude unamortized original issue premiums.

TARRANT REGIONAL WATER DISTRICT

SCHEDULE OF CHANGES IN BONDED DEBT
FOR THE YEAR ENDED SEPTEMBER 30, 2014 (UNAUDITED)

	Balance October 1, 2013	Total Issued	Total Retired	Balance September 30, 2014
Tarrant Regional Water District Projects				
Water Revenue Bonds —series 2006	$ 182,905,000			$ 182,905,000
Water Revenue Bonds —series 2008A-RC	2,955,000		$ 185,000	2,770,000
Water Revenue Bonds —series 2008B-CC	4,375,000			4,375,000
Water Revenue Refunding and Improvement —series 2009	53,845,000			53,845,000
Water Revenue Bonds —series 2010	89,250,000			89,250,000
Water Revenue Bonds —series 2010A	17,835,000			17,835,000
Water Revenue Bonds —series 2010B	74,185,000		3,395,000	70,790,000
Water Revenue Bonds —series 2012	150,375,000		5,385,000	144,990,000
Water Revenue Refunding Bonds —series 2012A	97,275,000		18,585,000	78,690,000
Water Revenue Bonds —series 2014	-	$ 318,750,000		318,750,000
	673,000,000	318,750,000	27,550,000	964,200,000
TRWD Contract Revenue Bonds (City of Dallas Project)				
Contract Revenue Bonds (City of Dallas Project) —series 2012	129,235,000		2,760,000	126,475,000
Contract Revenue Bonds (City of Dallas Project) —series 2014	-	202,130,000		202,130,000
	129,235,000	202,130,000	2,760,000	328,605,000
Total	$ 802,235,000	$ 520,880,000	$ 30,310,000	$ 1,292,805,000

Note: Above amounts exclude unamortized original issue premiums.

TARRANT REGIONAL WATER DISTRICT

GENERAL GOVERNMENTAL EXPENDITURES BY FUNCTION (1)
LAST 10 FISCAL YEARS (UNAUDITED)

Fiscal Year	Administrative		Maintenance and Warehouse	Tax Assessing and Collecting
2005	$ 4,379,995		$ 3,831,855	$ 157,413
2006	4,921,537		4,214,926	168,843
2007	11,468,757	(2)	4,638,174	177,719
2008	10,761,691		5,152,642	188,141
2009	9,916,759		5,041,273	223,329
2010	7,464,592		5,802,893	268,144
2011	5,870,935	(3)	5,993,362	262,644
2012	7,395,829		5,998,138	259,615
2013	8,227,077		6,551,189	377,099
2014	25,429,379	(4)	6,901,056	482,268

(1) Includes General Fund expenditures but excludes capital expenditures and depreciation expense.

(2) Increase is related to an increase in contributions to the Trinity River Vision Project.

(3) Decrease due to more expenses being allocated to the Enterprise Fund due to the large bond projects.

(4) Increase is related to an increase in contributions to the Trinity River Vision Project, largely due to the $18.4 million contribution to Texas Department of Transportation for the bridges.

TARRANT REGIONAL WATER DISTRICT

ENTERPRISE FUND EXPENSES
LAST 10 FISCAL YEARS (UNAUDITED)

Fiscal Year	Operating Maintenance and Administrative		Interest Expense		Depreciation and Amortization
2005	$ 21,663,253		$ 11,403,366		$ 10,272,674
2006	41,458,563	(1)	14,830,399		10,179,471
2007	31,468,193		16,072,941		10,206,921
2008	33,107,306		10,823,849		11,798,556
2009	37,456,752		19,423,791		15,284,771
2010	33,748,148		19,714,313		15,663,973
2011	41,441,508	(1)	19,140,654		16,174,207
2012	46,127,011	(1)	19,238,227		16,656,082
2013	55,653,489	(1)	14,938,583	(2)	16,573,425
2014	69,552,995	(1)	18,920,099	(3)	16,428,450

(1) Increase due to an increase in pumping power costs due to the drought conditions.

(2) Decrease in interest expense due to refunding of the 2002 Bond Issuance.

(3) Increase in interest expense due to issuance of 2014 Bonds.

TARRANT REGIONAL WATER DISTRICT

GENERAL GOVERNMENTAL REVENUES BY SOURCE
LAST 10 FISCAL YEARS (UNAUDITED)

Fiscal Year	Oil and Gas Royalties		Land Lease Rentals	Interest Income	Transfer/ Other		Property Taxes
2005	$ 23,472,113		$ 250,076	$ 968,967	$ 538,454		$ 5,959,884
2006	28,800,533		257,644	2,684,659	1,419,866	(1)	6,561,859
2007	34,007,763		370,305	4,455,483	6,278,019		7,322,427
2008	68,057,516	(2)	348,619	4,100,005	5,328,653		8,056,037
2009	34,397,855		327,741	3,137,581	2,469,605		8,735,179
2010	34,354,862		656,328	1,468,495	603,740	(3)	9,002,136
2011	27,777,427	(4)	662,857	1,045,664	1,466,505		8,600,104
2012	20,738,333	(4)	875,426	708,010	9,042,451	(5)	8,857,981
2013	31,367,889	(6)	1,385,702	300,771	4,345,035	(5)	8,993,946
2014	24,518,478	(4)	1,314,725	367,655	3,710,328	(5)	9,263,039

(1) As of 2006 transfers were included in this total.

(2) The District entered into new oil and gas leases which included significant bonus payments and operating royalties.

(3) As of 2010 interfund revenue was not included in the number, it was treated as a contra expense.

(4) Oil and gas royalties are reflective of a down market as well as a reduced number of bonus payment

(5) In 2012 $8.0 million was received under the Project Cost Fund agreement between TRWD and TIF, in 2013 $2.8 million was received from the TIF, and in 2014 $3.1 million was received from the TIF.

(6) Oil and gas royalties increased due to an increase in production, increased market prices, and the collection of back royalties due to the Oil and Gas third party audit.

TARRANT REGIONAL WATER DISTRICT

ENTERPRISE FUND REVENUES
LAST 10 FISCAL YEARS (UNAUDITED)

Fiscal Year	Sale of Water		Investment Income		Land Lease Rentals	Other (1)	
2005	$60,126,522		$ 1,868,698		$ 109,233	$ 1,321,587	
2006	80,343,028		6,716,967		55,109	1,462,521	
2007	73,740,294		10,613,665		99,728	976,123	
2008	66,486,843		4,550,301	(2)	77,933	1,667,723	
2009	80,469,426		3,486,297		67,692	318,089	
2010	79,465,525		2,969,407		78,480	290,656	
2011	90,310,650	(3)	1,873,044		79,586	1,512,159	(4)
2012	98,844,939	(3)	2,183,834		76,624	650,548	
2013	120,043,265	(3)	262,520		85,681	1,129,678	
2014	135,783,975	(3)	1,598,019		88,640	985,602	

(1) Other revenues include contributions, gains on sale of investments and property, plant and equipment, and buy-in premiums.

(2) Decrease due to large down turn in bonds market.

(3) Increase in water sales due to system costs related to debt service and pumping power.

(4) Increase in 2011 due to cost reimbursement from Dallas Water Utilities.

TARRANT REGIONAL WATER DISTRICT

PROPERTY TAX LEVIES AND COLLECTIONS
LAST 10 FISCAL YEARS (UNAUDITED)

Fiscal Year	Total Tax Levy	Current Tax Collections	Ratio of Current Tax Collections to Total Tax Levy	Delinquent Tax Collections	Ratio of Delinquent Tax Collections to Total Tax Levy	Total Tax Collections	Ratio of Total Tax Collections to Total Tax Levy
2005	$ 5,955,710	$ 5,857,339	98.3%	$ 102,545	1.72%	$ 5,959,884	100.1%
2006	6,523,826	6,482,144	99.4%	109,990	1.69%	6,592,134	101.0%
2007	7,301,143	7,226,033	99.0%	96,394	1.32%	7,322,427	100.3%
2008	8,006,321	7,972,642	99.6%	96,975	1.21%	8,069,617	100.8%
2009	8,692,629	8,576,152	98.7%	62,858	0.72%	8,639,010	99.4%
2010	8,961,076	8,836,802	98.6%	112,749	1.26%	8,949,551	99.9%
2011	8,585,136	8,461,681	98.6%	71,226	0.83%	8,532,907	99.4%
2012	8,778,407	8,664,270	98.7%	112,467	1.28%	8,776,737	100.0%
2013	8,934,929	8,820,523	98.7%	111,025	1.24%	8,931,548	100.0%
2014	9,192,432	9,083,100	98.8%	94,414	1.03%	9,177,514	99.8%

TARRANT REGIONAL WATER DISTRICT

ASSESSED AND ACTUAL ESTIMATED VALUE OF PROPERTY
LAST 10 FISCAL YEARS (UNAUDITED)

Fiscal Year	Assessed Valuation	Estimated Actual Valuation	Ratio of Assessed Valuation to Estimated Actual Valuation
2005	$ 29,337,958,539	$ 29,778,521,629	98.5%
2006	31,686,327,914	31,760,084,866	99.8%
2007	36,055,574,973	36,506,443,351	98.8%
2008	40,031,703,354	39,887,627,798	100.4%
2009	43,463,173,474	41,425,734,107	104.9%
2010	44,802,386,393	42,709,872,649	104.9%
2011	42,636,798,867	42,925,679,331	99.3%
2012	43,715,648,106	43,892,079,947	99.6%
2013	44,476,657,492	44,674,429,572	99.6%
2014	45,346,218,693	45,962,219,088	98.7%

Note: All taxes are recorded in the General Fund.

TARRANT REGIONAL WATER DISTRICT
ENTERPRISE FUND DEBT SERVICE REQUIREMENTS TO MATURITY (IN THOUSANDS) 2014 (UNAUDITED)
TARRANT REGIONAL WATER DISTRICT PROJECT

YR	2006 - Water Revenue			2008A WIF			2008B WIF			2009 - Water Revenue			2010 - Water System			2010 A - Series 2010A			2010 B - Series 2010B			2012 - Refunding and			2012A - Refunding			2014 - Revenue Bonds			Total Enterprise Funds		
	Princ.	Int.	Total	Princ.	Int.	Total	Princ.	Int.	Total	Princ.	Int.	Total	Princ.	Int.	Total	Princ.	Int.	Total	Princ.	Int.	Total	Princ.	Int.	Total	Princ.	Int.	Total	Princ.	Int.	Total	Princ.	Int.	Total
2015	$	8,530	8,530	$ 185	65	250				$	2,692	2,692	$	4,153	4,153				$ 3,500	1,253	4,753	$ 5,660	6,998	12,658	$ 19,445	3,365	22,810	$ 2,490	15,852	18,342	$ 31,280	42,908	74,188
2016		8,530	8,530	190	61	251					2,692	2,692		4,153	4,153				3,605	1,243	4,848	5,950	6,708	12,658	20,440	2,368	22,808		15,802	15,802	30,185	41,557	71,742
2017		8,530	8,530	195	58	253					2,692	2,692		4,153	4,153				3,715	1,220	4,935	6,100	6,407	12,507	20,965	1,333	22,298		15,802	15,802	30,975	40,195	71,170
2018	8,700	8,347	17,047	195	54	249	$ 605	100	705	3,360	2,608	5,968	2,120	4,106	6,226	$ 1,305	243	1,548	3,830	1,186	5,016	735	6,247	6,982	3,255	728	3,983		15,802	15,802	24,105	39,421	63,526
2019	9,080	7,969	17,049	200	50	250	620	87	707	3,530	2,436	5,966	2,230	4,008	6,238	1,160	352	1,512	3,945	1,144	5,089	750	6,228	6,978	3,410	572	3,982	895	15,779	16,674	25,820	38,625	64,445
2020	9,480	7,568	17,048	205	46	251	630	73	703	3,710	2,255	5,965	2,345	3,899	6,244	1,200	335	1,535	4,065	1,091	5,156	770	6,209	6,979	3,555	427	3,982	1,405	15,722	17,127	27,365	37,625	64,990
2021	9,905	7,145	17,050	210	40	250	645	58	703	3,900	2,065	5,965	2,465	3,779	6,244	1,235	314	1,549	4,190	1,026	5,216	790	6,190	6,980	3,720	263	3,983	805	15,667	16,472	27,865	36,547	64,412
2022	10,350	6,701	17,051	215	35	250	665	41	706	4,100	1,865	5,965	2,590	3,653	6,243	1,270	291	1,561	4,315	951	5,266	815	6,166	6,981	3,900	85	3,985	1,125	15,624	16,749	29,345	35,412	64,757
2023	16,690	6,102	22,792	220	30	250	680	23	703	4,315	1,654	5,969	2,720	3,520	6,240	1,310	264	1,574	4,450	868	5,318		6,154	6,154					15,602	15,602	30,385	34,217	64,602
2024	17,450	5,342	22,792	225	23	248	530	7	537	4,535	1,433	5,968	2,860	3,395	6,255	1,350	236	1,586	4,585	776	5,361		6,153	6,153					15,602	15,602	31,535	32,967	64,502
2025	18,300	4,496	22,796	235	17	252				4,765	1,201	5,966	3,010	3,277	6,287	1,390	207	1,597	4,725	676	5,401		6,154	6,154					15,602	15,602	32,425	31,630	64,055
2026	19,235	3,558	22,793	240	11	251				5,010	956	5,966	3,160	3,138	6,298	1,435	174	1,609	4,865	569	5,434		6,153	6,153					15,602	15,602	33,945	30,161	64,106
2027	20,220	2,572	22,792	255	4	259				5,265	699	5,964	3,325	2,976	6,301	1,475	139	1,614	5,015	454	5,469		6,154	6,154					15,602	15,602	35,555	28,600	64,155
2028	21,230	1,562	22,792							5,535	429	5,964	3,495	2,805	6,300	1,520	102	1,622	5,170	331	5,501		6,153	6,153					15,602	15,602	36,950	26,984	63,934
2029	22,265	529	22,794							5,820	146	5,966	3,675	2,626	6,301	1,570	62	1,632	5,325	202	5,527		6,154	6,154					15,602	15,602	38,655	25,321	63,976
2030													3,865	2,438	6,303	1,615	21	1,636	5,490	68	5,558		6,153	6,153				18,735	15,133	33,868	29,705	23,813	53,518
2031													4,060	2,255	6,315							6,450	5,992	12,442				20,355	14,156	34,511	30,865	22,403	53,268
2032													4,270	2,062	6,332							6,750	5,671	12,421				21,145	13,118	34,263	32,165	20,851	53,016
2033													4,490	1,857	6,347							7,065	5,334	12,399				21,980	12,040	34,020	33,535	19,231	52,766
2034													4,720	1,652	6,372							7,375	4,973	12,348				22,880	10,919	33,799	34,975	17,544	52,519
2035													4,960	1,434	6,394							7,725	4,596	12,321				9,495	10,109	19,604	22,180	16,139	38,319
2036													5,215	1,205	6,420							8,070	4,201	12,271				9,980	9,623	19,603	23,265	15,029	38,294
2037													5,480	965	6,445							8,445	3,788	12,233				10,490	9,111	19,601	24,415	13,864	38,279
2038													5,765	708	6,473								3,577	3,577				11,030	8,573	19,603	16,795	12,858	29,653
2039													6,060	435	6,495								3,577	3,577				11,595	8,007	19,602	17,655	12,019	29,674
2040													6,370	147	6,517								3,577	3,577				12,190	7,413	19,603	18,560	11,137	29,697
2041																						4,460	3,466	7,926				12,815	6,787	19,602	17,275	10,253	27,528
2042																						4,690	3,237	7,927				13,470	6,130	19,600	18,160	9,367	27,527
2043																						4,930	2,996	7,926				14,160	5,440	19,600	19,090	8,436	27,526
2044																						5,185	2,743	7,928				14,890	4,713	19,603	20,075	7,456	27,531
2045																						5,450	2,478	7,928				15,650	3,950	19,600	21,100	6,428	27,528
2046																						5,730	2,198	7,928				16,455	3,147	19,602	22,185	5,345	27,530
2047																						6,025	1,904	7,929				17,330	2,303	19,633	23,355	4,207	27,562
2048																						6,330	1,595	7,925				18,220	1,414	19,634	24,550	3,009	27,559
2049																						6,655	1,271	7,926				19,165	479	19,644	25,820	1,750	27,570
2050																						6,995	929	7,924							6,995	929	7,924
2051																						7,355	571	7,926							7,355	571	7,926
2052																						7,735	193	7,928							7,735	193	7,928
	$ 182,905	87,481	270,386	$ 2,770	494	3,264	$ 4,375	389	4,764	$ 53,845	25,823	79,668	89,250	68,799	158,049	17,835	2,740	20,575	70,790	13,058	83,848	$ 144,990	169,248	314,238	$ 78,690	9,141	87,831	$ 318,750	387,829	706,579	$ 964,200	765,002	1,729,202

TARRANT REGIONAL WATER DISTRICT

ENTERPRISE FUND DEBT SERVICE REQUIREMENTS TO MATURITY (IN THOUSANDS) 2014 (UNAUI

TRWD CONTRACT REVENUE BONDS (CITY OF DALLAS PROJECT)

	Dallas 2012 - Series 2012			Dallas 2014 - Series 2014			Total Contract Revenue		
YR	Princ.	Int.	Total	Princ.	Int.	Total	Princ.	Int.	Total
2015	2,835	5,066	7,901	3,040	10,281	13,321	5,875	15,347	21,222
2016	2,895	4,953	7,848	3,195	10,098	13,293	6,090	15,051	21,141
2017	2,955	4,808	7,763	3,355	9,907	13,262	6,310	14,715	21,025
2018	3,015	4,660	7,675	3,520	9,705	13,225	6,535	14,365	20,900
2019	3,075	4,509	7,584	3,700	9,494	13,194	6,775	14,003	20,778
2020	3,140	4,356	7,496	3,885	9,272	13,157	7,025	13,628	20,653
2021	3,200	4,199	7,399	4,075	9,039	13,114	7,275	13,238	20,513
2022	3,270	4,039	7,309	4,280	8,795	13,075	7,550	12,834	20,384
2023	3,345	3,875	7,220	4,495	8,538	13,033	7,840	12,413	20,253
2024	3,515	3,708	7,223	4,720	8,268	12,988	8,235	11,976	20,211
2025	3,620	3,602	7,222	4,955	7,985	12,940	8,575	11,587	20,162
2026	3,765	3,458	7,223	5,205	7,688	12,893	8,970	11,146	20,116
2027	3,920	3,307	7,227	5,465	7,479	12,944	9,385	10,786	20,171
2028	4,075	3,189	7,264	5,735	7,261	12,996	9,810	10,450	20,260
2029	4,240	3,067	7,307	6,025	7,031	13,056	10,265	10,098	20,363
2030	4,415	2,940	7,355	6,325	6,730	13,055	10,740	9,670	20,410
2031	4,595	2,808	7,403	6,640	6,414	13,054	11,235	9,222	20,457
2032	4,780	2,664	7,444	6,975	6,082	13,057	11,755	8,746	20,501
2033	4,970	2,473	7,443	7,320	5,733	13,053	12,290	8,206	20,496
2034	5,225	2,274	7,499	7,690	5,367	13,057	12,915	7,641	20,556
2035	5,485	2,065	7,550	8,075	4,982	13,057	13,560	7,047	20,607
2036	5,765	1,846	7,611	8,475	4,579	13,054	14,240	6,425	20,665
2037	6,055	1,615	7,670	8,900	4,155	13,055	14,955	5,770	20,725
2038	6,360	1,373	7,733	9,345	3,710	13,055	15,705	5,083	20,788
2039	6,605	1,118	7,723	9,810	3,243	13,053	16,415	4,361	20,776
2040	6,855	854	7,709	10,300	2,752	13,052	17,155	3,606	20,761
2041	7,115	580	7,695	10,815	2,237	13,052	17,930	2,817	20,747
2042	7,385	295	7,680	11,360	1,697	13,057	18,745	1,992	20,737
2043				11,925	1,129	13,054	11,925	1,129	13,054
2044				12,525	532	13,057	12,525	532	13,057
	$ 126,475	83,701	210,176	$ 202,130	190,183	392,313	$ 328,605	273,884	602,489

TARRANT REGIONAL WATER DISTRICT

MISCELLANEOUS STATISTICAL FACTS
AS OF SEPTEMBER 30, 2014 (UNAUDITED)

Date of organization	October 7, 1924
Area covered by District	345 square miles
Facilities:	
Number of water supply reservoirs	4

	Conservation Pool	Actual in Storage
Acre feet of water storage:		
Bridgeport Lake	366,236	200,516
Eagle Mountain Lake	182,505	135,340
Cedar Creek Lake	644,785	488,901
Richland Chambers	1,137,204	801,209
Total	2,330,730	1,625,966

Miles of levees	23
Miles of floodway river channel	27
Area to be maintained by District	1,997 acres
Employees:	
Administrative and office	139
Maintenance	105

Annual rainfall in inches—last 10 calendar years:

Year	DFW Weather Service	Lake Worth	Eagle Mountain Lake	Bridgeport Lake	Cedar Creek Lake	Richland/ Chambers
2004	47.57	42.55	50.61	33.78	40.96	41.51
2005	18.97	13.69	17.62	11.51	20.07	19.42
2006	29.75	26.60	23.56	27.95	26.90	29.18
2007	50.05	40.88	45.06	36.80	51.94	53.56
2008	27.10	27.09	27.39	25.58	26.30	30.09
2009	40.89	31.48	27.86	33.20	43.23	54.54
2010	37.55	32.46	34.93	36.01	24.83	38.68
2011	25.88	17.94	20.67	25.13	22.56	30.79
2012	31.26	25.18	24.32	23.32	30.06	30.83
2013	29.40	24.28	25.18	24.70	24.82	34.82

TARRANT REGIONAL WATER DISTRICT

SCHEDULE OF INSURANCE
AS OF SEPTEMBER 30, 2014 (UNAUDITED)

Insurer	Policy Period	Type of Coverage	Limits
Hartford Insurance Co. [1]	03/29/14–03/29/15 03/29/13–03/29/14	Crime	$500,000—liability
	01/15/13-until canceled	Director Bond	$10,000—per director
TWCA Risk Management Fund [2]	07/01/13–07/01/14 07/01/14–07/01/15	Fleet Policy	$10,000,000—liability
	07/01/13–07/01/14 07/01/14–07/01/15	Property Insurance	$260,552,875—blanket limit $287,580,288—blanket limit
	07/01/13–07/01/14 07/01/14–07/01/15	Workers' Compensation	Statutory limits
	07/01/13–07/01/14 07/01/14–07/01/15	General Liability	$10,000,000—limit
	07/01/13–07/01/14 07/01/14–07/01/15	Errors and Omissions Liability	$10,000,000—limit
	07/01/13–07/01/14	Rental Coverage [3]	$250,000—limit
Blue Cross Blue Shield of Texas	01/01/14–12/31/15	Health Insurance	Unlimited per employee
Sutton James Insurance Broker	12/15/12-12/15/13 12/16/13-12/16/14	Aviation Coverage	$370,000—Physical Damage $5,000,000—Liability
Willis of Texas, Inc. [4]	07/01/13–07/01/14 07/01/14–07/01/15	Rolling Owner Controlled Insurance Program - IPL	$1,000,000 —Commercial General Liability $1,000,000 —Automobile Liability

[1] This is a pool administered by J. I. Specialty Services.

[2] This is a pool through the Texas Water Conservation Association Risk Management Fund administered by J. I. Specialty Services.

[3] As of 7/2/14, the District has elected to forego Rental Reimbursement Coverage.

[4] Willis of Texas is the broker/administrator who supports the self-insurance held on the IPL project

The District has paid all premiums due prior to September 30, 2014.

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Tarrant Regional Water District
Quarterly Financial Report
For the Quarter Ended

March 31, 2015

Tarrant Regional Water District
Budget vs. Actual

TARRANT REGIONAL WATER DISTRICT

STATEMENT OF NET POSITION
MARCH 31, 2015

	Primary Government			
	Governmental Activities	Business-Type Activities	Total	Component Unit
ASSETS:				
Cash and cash equivalents	$ 59,345,103	$ 12,399,872	$ 71,744,975	$ 2,243,370
Investments	47,135,959	6,002,601	53,138,560	
Receivables:				
Accounts, oil and gas royalties, and other	3,356,382	1,074,541	4,430,923	105,490
Accrued interest	100,101	28,292	128,393	
Long-term receivable	103,865,439		103,865,439	
Internal balances	6,684,174	(6,684,174)	-	
Prepaid items	3,252,642	12,595,837	15,848,479	13,439
Inventory of supplies-at cost	54,573		54,573	
Cash and cash equivalents for bond projects		138,529,032	138,529,032	
Investments held for bond projects		371,098,644	371,098,644	
Accrued interest receivable for bond projects		373,959	373,959	
Cash and cash equivalents restricted		1,100,000	1,100,000	
Cash and cash equivalents for debt service		10,941,353	10,941,353	
Investments restricted for debt service		83,731,706	83,731,706	
Accrued interest receivable restricted for debt service		243,661	243,661	
Land	196,196,422	137,036,480	333,232,902	
Construction in progress	60,520,733	445,165,697	505,686,430	
Depreciable capital assets, net of accumulated depreciation	32,817,580	565,604,666	598,422,246	
Water rights, net of amortization		492,670	492,670	
Total Assets	513,329,108	1,779,734,837	2,293,063,945	2,362,299
DEFERRED OUTFLOWS OF RESOURCES:				
Deferred bond refunding-loss			-	
LIABILITIES:				
Accounts payable	3,148,195	2,810,262	5,958,457	384,238
Accrued vacation - due within one year	201,354	580,424	781,778	
Other liabilities	2,064,305	9,406,730	11,471,035	2,594,972
Payable from restricted assets - Accrued bond interest payable		5,438,833	5,438,833	
Revenue bonds payable, net of discount				
Due within one year		36,820,000	36,820,000	
Due in more than one year		1,319,088,187	1,319,088,187	
Long-term Payables				
Long-term arbitrage rebate payable		-	-	
Accrued Litigation Judgements			-	
Pollution Remediation Obligations	20,346,110		20,346,110	
Post employment benefits payable	3,319,110	6,454,804	9,773,914	
Accrued Vacation - due in more than one year	470,853	1,357,284	1,828,137	
Total Liabilities	29,549,927	1,381,956,524	1,411,506,451	2,979,210
DEFERRED INFLOWS OF RESOURCES:				
Deferred bond refunding-gain		4,569,061	4,569,061	
NET POSITION:				
Net investment in capital assets	289,534,735	297,823,900	587,358,635	-
Restricted for debt service		90,577,887	90,577,887	-
Unrestricted	194,244,446	4,807,465	199,051,911	(616,911)
Total Net Position	$ 483,779,181	$ 393,209,252	$ 876,988,433	$ (616,911)

TARRANT REGIONAL WATER DISTRICT

STATEMENT OF ACTIVITIES
FOR THE QUARTER ENDED MARCH 31, 2015

Functions/Programs	Expenses	Program Revenues: Charges for services	Program Revenues: Capital Grants and Contributions	Net (Expense) Revenue and Changes in Net Position: Primary Government: Governmental Activities	Primary Government: Business Type Activities	Primary Government: Total	Component Unit
PRIMARY GOVERNMENT							
Governmental activities:							
General government	$ 5,076,819	$ 10,519,686	$ 11,865,723	$ 17,308,590		$ 17,308,590	
Flood control	2,108,220			(2,108,220)		(2,108,220)	
Total governmental activities	7,185,039	10,519,686	11,865,723	15,200,370		15,200,370	
Business type activities-water supply	55,928,480	74,284,057			$ 18,355,577	18,355,577	
TOTAL	$ 63,113,519	$ 84,803,743	$ 11,865,723	$ 15,200,370	$ 18,355,577	$ 33,555,947	
COMPONENT UNIT							
Trinity River Vision Authority							
Project Development	10,271,458	9,573,851					$ (697,607)
Recreation Programs	173,450	191,928	35,500				53,978
Total Component Unit	$ 10,444,908	$ 9,765,779	$ 35,500				$ (643,629)
GENERAL REVENUES (EXPENSES):							
Property taxes				9,128,054	-	9,128,054	
Investment income				275,443	2,321,258	2,596,701	279
Miscellaneous				32,649	637,958	670,607	2,100
Gain/loss on disposal of assets				44,752	27,243	71,995	
Total general revenues and transfers				9,480,898	2,986,459	12,467,357	2,379
CHANGES IN NET POSITION				24,681,268	21,342,036	46,023,304	(641,250)
NET POSITION-----Beginning of year				459,097,913	371,867,216	830,965,129	24,339
NET POSITION-----March 31, 2015				$ 483,779,181	$ 393,209,252	$ 876,988,433	$ (616,911)

TARRANT REGIONAL WATER DISTRICT

BALANCE SHEET—GENERAL FUND
MARCH 31, 2015

ASSETS		
CASH AND CASH EQUIVALENTS	$	59,345,103
INVESTMENTS		47,135,959
RECEIVABLES:		
Oil and gas royalties and other		3,356,382
Accrued interest		100,101
DUE FROM ENTERPRISE FUND		5,913,235
NOTES AND INTEREST DUE FROM ENTERPRISE FUND		770,939
PREPAID ITEMS		3,252,642
INVENTORY OF SUPPLIES—At cost		54,573
LONG-TERM RECEIVABLE		103,865,439
TOTAL ASSETS	$	223,794,373
LIABILITIES:		
ACCOUNTS PAYABLE	$	3,148,195
OTHER LIABLITIES		1,575,922
TOTAL LIABILITIES		4,724,117
DEFERRED INFLOWS:		
UNAVAILABLE REVENUE		103,865,439
TOTAL DEFERRED INFLOWS		103,865,439
FUND BALANCES:		
Nonspendable:		
Long-term interfund notes and interest		770,939
Prepaid items		3,252,642
Inventory of supplies - At cost		54,573
Unassigned		111,126,663
Total fund balances		115,204,817
TOTAL	$	223,794,373

RECONCILIATION OF BALANCE SHEET-GENERAL FUND TO GOVERNMENT-WIDE STATEMENT OF NET POSITION
MARCH 31, 2015

TOTAL FUND BALANCES—General Fund	$115,204,817
Amounts reported for governmental activities in the statement of net position are different because:	
Certain revenues do not provide current financial resources and are therefore are unavailable at the fund level	
TIF loan long term receivable	103,865,439
Certain liabilities are not payable from current resources and are therefore not accrued at the fund level	(24,337,427)
Certain leases are not due and payable in the current period and therefore are not reported as liablities to governmental funds.	(488,383)
Captial assets used in governmental activities are not financial resources and therefore are not reported as assets in governmental funds	289,534,735
TOTAL NET POSITION—Governmental activities	$483,779,181

TARRANT REGIONAL WATER DISTRICT

STATEMENT OF REVENUES, EXPENDITURES, AND CHANGES IN FUND BALANCES—GENERAL FUND

FOR THE QUARTER ENDED MARCH 31, 2015

REVENUES:		
Property taxes	$	9,140,050
Lease rentals		1,223,165
Oil and gas royalties		9,584,992
Investment income		275,443
Other		204,651
Total revenues		20,428,301
EXPENDITURES:		
Current:		
General and administrative		5,789,069
Personnel services		2,383,025
Pension plan contribution		259,113
Capital expenditures		12,465,233
Total expenditures		20,896,440
DEFICIENCY OF REVENUES UNDER EXPENDITURES		(468,139)
CHANGE IN FUND BALANCES		(468,139)
FUND BALANCES—Beginning of year		115,672,956
FUND BALANCES—March 31, 2015	$	115,204,817

TARRANT REGIONAL WATER DISTRICT

RECONCILIATION OF STATEMENT OF REVENUES, EXPENDITURES, AND CHANGES IN FUND BALANCES--GENERAL FUND--TO GOVERNMENT WIDE STATEMENT OF ACTIVITIES FOR THE QUARTER ENDED MARCH 31, 2015

CHANGE IN FUND BALANCES—General Fund	($468,139)
Amounts reported for governmental activities in the statement of net position are different because:	
Revenues in the statement of activities that do not provide current financial resources are not reported as revenues in the fund.	
Change in unavailable revenue-TIF	11,865,723
Change in unavailable property taxes	(11,996)
Change in unavailable oil and gas revenue	(415,721)
Certain liabilities are not paybale from current resources and are therefore not accrued in the fund.	1,246,168
The general fund reports capital outlays as expenditures. However, in the statement of activities the cost of those assets is allocated over their estimated useful lives and reported as depreciation expense. This is the amount by which capital outlays exceed expenditures.	12,465,233
CHANGE IN NET POSITION—Governmental activities	$24,681,268

TARRANT REGIONAL WATER DISTRICT

STATEMENT OF NET POSITION—ENTERPRISE FUND
MARCH 31, 2015

ASSETS:

Current:		
Cash and cash equivalents	$	12,399,872
Investments		6,002,601
Receivables:		
Accounts and other		1,074,541
Accrued interest		28,292
Prepaid items		12,595,837
Total current assets		32,101,143
Noncurrent:		
Cash and cash equivalents-Bond projects		138,529,032
Investments-Bond projects		371,098,644
Accrued interest receivable-Bond projects		373,959
Cash and cash equivalents-Contingency		1,100,000
Cash and cash equivalents-Restricted for non-current debt service		10,941,353
Investments-Restricted for non-current debt service		83,731,706
Accrued interest receivable-Restricted for non-current debt service		243,661
Capital Assets:		
Land		137,036,480
Construction in progress		445,165,697
Depreciable capital assets—net		565,604,666
Water rights—net of amortization		492,670
Total noncurrent assets		1,754,317,868
Total assets	$	1,786,419,011

DEFERRED OUTFLOWS OF RESOURCES:

Deferred bond refunding-loss		-

(Continued)

TARRANT REGIONAL WATER DISTRICT

STATEMENT OF NET POSITION—ENTERPRISE FUND
MARCH 31, 2015

LIABILITIES:		
Current Liabilities:		
Accounts payable	$	2,810,262
Due to General Fund		5,913,235
Accrued vacation		580,424
Other liabilities		9,406,730
Payable from restricted assets—accrued bond interest payable		5,438,833
Revenue bonds payable		36,820,000
Notes and interest payable to General Fund		127,568
Total current liabilities		61,097,052
Noncurrent Liabilities:		
Accrued vacation		1,357,284
Long-term post employment benefits		6,454,804
Revenue bonds payable—net of discount		1,319,088,187
Notes and interest payable to General Fund		643,371
Total noncurrent liabilities		1,327,543,646
Total liabilities		1,388,640,698
DEFERRED INFLOWS OF RESOURCES:		
Deferred bond refunding-gain		4,569,061
NET POSITION:		
Net investment in capital assets		297,823,900
Restricted for debt service		90,577,887
Unrestricted		4,807,465
TOTAL NET POSITION	$	393,209,252

(Concluded)

TARRANT REGIONAL WATER DISTRICT

STATEMENT OF REVENUES, EXPENSES, AND CHANGES IN NET POSITION—ENTERPRISE FUND FOR THE QUARTER ENDED MARCH 31, 2015

OPERATING REVENUES:		
Sale of water	$	63,518,545
Sale of System Capacity		10,610,903
Land lease rentals		26,710
Sale of power		9,912
Other		755,945
Total operating revenues		74,922,015
OPERATING EXPENSES:		
General and administrative		8,600,239
Personnel services		5,597,063
Utilities		11,094,862
Pension plan contribution		616,586
Total operating expenses		25,908,750
OPERATING INCOME		49,013,265
NONOPERATING INCOME (EXPENSE):		
Investment income		2,321,258
Interest expense		(30,019,730)
Gain on disposal of capital assets		27,243
Total nonoperating income (expense)		(27,671,229)
NET INCOME		21,342,036
NET POSITION—Beginning of year		371,867,216
NET POSITION—March 31, 2015	$	393,209,252

TARRANT REGIONAL WATER DISTRICT

STATEMENT OF NET POSITION - FIDUCIARY FUND
FOR THE QUARTER ENDED MARCH 31, 2015

	Other Post-Employment Benefits Trust Fund
ASSETS	
Current assets:	
Cash & cash equivalents	$ 2,040,120
Total assets	2,040,120
NET POSITION	
Net assets held in trust for other employee benefits:	
Postemployment healthcare plans	2,040,120
Total Net Position	$ 2,040,120

TARRANT REGIONAL WATER DISTRICT

STATEMENT OF CHANGES IN NET POSITION - FIDUCIARY FUND
FOR THE QUARTER ENDED MARCH 31, 2015

	Other Post-Employment Benefits Trust Fund
ADDITIONS	
Employer contributions	$ 1,000,000
Net gain (loss) in fair value of investments	43,960
Total Additions	1,043,960
DEDUCTIONS	
Admininstrative expenses	3,704
Total Deductions	3,704
CHANGE IN NET POSITION	1,040,256
NET POSITION—Beginning of year	999,864
NET POSITION—End of year	$ 2,040,120

TARRANT REGIONAL WATER DISTRICT
Notes to the Quarterly Financial Report
March 31, 2015

NOTE 1 - The total column on the Combined Balance Sheet is presented only to facilitate financial analysis. Data in this column does not present financial position, results of operations or changes in financial position in conformity with generally accepted accounting principles. Neither is such data comparable to consolidation. Inter-fund eliminations have not been made in the aggregation of this data.

NOTE 2 - At March 31, 2015, the District's long term debt consisted of:

	ENTERPRISE
Tarrant Regional Water District Projects	
Series 2008A Richland Chambers Wetlands Bonds	2,585,000
Series 2008B Cedar Creek Wetlands Bonds	4,375,000
Series 2009 Water Revenue Bonds	53,845,000
Series 2010 Water Revenue Bonds	89,250,000
Series 2010 TWDB-A Bonds	17,835,000
Series 2010 TWDB-B Bonds	67,290,000
Series 2012 Water Revenue Bonds	139,330,000
Series 2012A Water Revenue Bonds	59,245,000
Series 2014 Water Revenue Bonds	316,260,000
Series 2015 Water Revenue Bonds	156,470,000
	906,485,000
TRWD Contract Revenue Bonds (City of Dallas Project)	
Series 2012 Dallas Water Revenue Bonds	126,475,000
Series 2014 Dallas Water Revenue Bonds	202,130,000
	328,605,000
Total-Construction and Improvements Bonds	1,235,090,000
ADD: Gain/Loss Refunding	4,569,061
ADD: Premium, net of accumulated amortization	120,818,187
	$1,360,477,248

NOTE 2 - Continued

Rollforward of Bonds Payable
Enterprise Fund

BONDS PAYABLE	BONDS PAYABLE BALANCE 9/30/2014	ACTIVITY	BONDS PAYABLE BALANCE 3/31/2015
Tarrant Regional Water District Projects			
Series 2006	182,905,000	(182,905,000)	0
Unamortized Premium	2,099,923	(2,099,923)	0
Gain/Loss Refunding	0	0	0
Series 2008A	2,770,000	(185,000)	2,585,000
Unamortized Premium	0	0	0
Gain/Loss Refunding	0	0	0
Series 2008B	4,375,000	0	4,375,000
Unamortized Premium	0	0	0
Gain/Loss Refunding	0	0	0
Series 2009	53,845,000	0	53,845,000
Unamortized Premium	2,576,085	0	2,576,085
Gain/Loss Refunding of 1999 Series	0	0	0
Series 2010	89,250,000	0	89,250,000
Unamortized Premium	2,335,863	0	2,335,863
Gain/Loss Refunding	0	0	0
Series 2010 TWDB-A	17,835,000	0	17,835,000
Unamortized Premium	0	0	0
Gain/Loss Refunding	0	0	0
Series 2010 TWDB-B	70,790,000	(3,500,000)	67,290,000
Unamortized Premium	0	0	0
Gain/Loss Refunding	0	0	0
Series 2012	144,990,000	(5,660,000)	139,330,000
Unamortized Premium	15,038,380	0	15,038,380
Gain/Loss Refunding of 1993 Series	0	0	0
Gain/Loss Refunding of 2002 Series	988,821	0	988,821
Series 2012A	78,690,000	(19,445,000)	59,245,000
Unamortized Premium	6,840,823	0	6,840,823
Gain/Loss Refunding of 1993 Series	0	0	0
Gain/Loss Refunding of 2002 Series	1,480,317	0	1,480,317
Series 2014	318,750,000	(2,490,000)	316,260,000
Unamortized Premium	28,778,326	0	28,778,326
Gain/Loss Refunding	0	0	0
Series 2012	0	156,470,000	156,470,000
Unamortized Premium	0	34,838,106	34,838,106
Gain/Loss Refunding of 2006 Series	0	2,099,923	2,099,923
	$1,024,338,538	$ (22,876,894.00)	$1,001,461,644
TRWD Contract Revenue Bonds (City of Dallas Project)			
Series 2012 Dallas	126,475,000	0	126,475,000
Unamortized Premium	6,036,146	0	6,036,146
Gain/Loss Refunding	0	0	0
Series 2014 Dallas	202,130,000	0	202,130,000
Unamortized Premium	24,374,458	0	24,374,458
Gain/Loss Refunding	0	0	0
	$359,015,604	$0	$359,015,604
Total-Construction and Improvement Bonds	$1,383,354,142	$ (22,876,894.00)	$1,360,477,248

NOTE 3 - At March 31, 2015, the District's Enterprise Fund Property, Plant and Equipment consisted of:

	REVENUE	CONSTRUCTION	TOTAL
Property, Plant & Equipment	$99,631,126	$1,346,119,283	$1,445,750,409
LESS: Accumulated Depreciation	79,651,105	218,292,461	297,943,566
TOTAL	$19,980,021	$1,127,826,822	$1,147,806,843

P or C #49 B
TRWD (DWU)

9/30/2015

Dallas Bonds

Dates	2012 Series- Contract Revenue Bonds (City of Dallas)			2014 Series- Contract Revenue Bonds (City of Dallas)			Total Enterprise Funds			Annual Payment	Avg Reserve Req after 9/1 Payment	Dallas Monthly Payments (Annual Payment / 12)
	Principal	Interest	Total	Principal	Interest	Total	Principal	Interest	Total			
3/1/2015		2,533,046.88	2,533,046.88		5,140,356.25	5,140,356.25	-	7,673,403.13	7,673,403.13			
9/1/2015	2,835,000.00	2,533,046.88	5,368,046.88	3,040,000.00	5,140,356.25	8,180,356.25	5,875,000.00	7,673,403.13	13,548,403.13			
9/30/2015										21,221,806.26	20,043,686.64	1,768,483.86
3/1/2016		2,476,346.88	2,476,346.88		5,049,156.25	5,049,156.25	-	7,525,503.13	7,525,503.13			
9/1/2016	2,895,000.00	2,476,346.88	5,371,346.88	3,195,000.00	5,049,156.25	8,244,156.25	6,090,000.00	7,525,503.13	13,615,503.13			
9/30/2016										21,141,006.26	20,004,496.66	1,761,750.52
3/1/2017		2,403,971.88	2,403,971.88		4,953,306.25	4,953,306.25	-	7,357,278.13	7,357,278.13			
9/1/2017	2,955,000.00	2,403,971.88	5,358,971.88	3,355,000.00	4,953,306.25	8,308,306.25	6,310,000.00	7,357,278.13	13,667,278.13			
9/30/2017										21,024,556.26	19,966,716.67	1,752,046.36
3/1/2018		2,330,096.88	2,330,096.88		4,852,656.25	4,852,656.25	-	7,182,753.13	7,182,753.13			
9/1/2018	3,015,000.00	2,330,096.88	5,345,096.88	3,520,000.00	4,852,656.25	8,372,656.25	6,535,000.00	7,182,753.13	13,717,753.13			
9/30/2018										20,900,506.26	19,930,801.69	1,741,708.86
3/1/2019		2,254,721.88	2,254,721.88		4,747,056.25	4,747,056.25	-	7,001,778.13	7,001,778.13			
9/1/2019	3,075,000.00	2,254,721.88	5,329,721.88	3,700,000.00	4,747,056.25	8,447,056.25	6,775,000.00	7,001,778.13	13,776,778.13			
9/30/2019										20,778,556.26	19,896,891.50	1,731,546.36
3/1/2020		2,177,846.88	2,177,846.88		4,636,056.25	4,636,056.25	-	6,813,903.13	6,813,903.13			
9/1/2020	3,140,000.00	2,177,846.88	5,317,846.88	3,885,000.00	4,636,056.25	8,521,056.25	7,025,000.00	6,813,903.13	13,838,903.13			
9/30/2020										20,652,806.26	19,865,395.06	1,721,067.19
3/1/2021		2,099,346.88	2,099,346.88		4,519,506.25	4,519,506.25	-	6,618,853.13	6,618,853.13			
9/1/2021	3,200,000.00	2,099,346.88	5,299,346.88	4,075,000.00	4,519,506.25	8,594,506.25	7,275,000.00	6,618,853.13	13,893,853.13			
9/30/2021										20,512,706.26	19,837,251.09	1,709,392.19
3/1/2022		2,019,346.88	2,019,346.88		4,397,256.25	4,397,256.25	-	6,416,603.13	6,416,603.13			
9/1/2022	3,270,000.00	2,019,346.88	5,289,346.88	4,280,000.00	4,397,256.25	8,677,256.25	7,550,000.00	6,416,603.13	13,966,603.13			
9/30/2022										20,383,206.26	19,812,434.95	1,698,600.52
3/1/2023		1,937,596.88	1,937,596.88		4,268,856.25	4,268,856.25	-	6,206,453.13	6,206,453.13			
9/1/2023	3,345,000.00	1,937,596.88	5,282,596.88	4,495,000.00	4,268,856.25	8,763,856.25	7,840,000.00	6,206,453.13	14,046,453.13			
9/30/2023										20,252,906.26	19,791,460.12	1,687,742.19
3/1/2024		1,853,971.88	1,853,971.88		4,134,006.25	4,134,006.25	-	5,987,978.13	5,987,978.13			
9/1/2024	3,515,000.00	1,853,971.88	5,368,971.88	4,720,000.00	4,134,006.25	8,854,006.25	8,235,000.00	5,987,978.13	14,222,978.13			
9/30/2024										20,210,956.26	19,770,485.32	1,684,246.36
3/1/2025		1,801,246.88	1,801,246.88		3,992,406.25	3,992,406.25	-	5,793,653.13	5,793,653.13			
9/1/2025	3,620,000.00	1,801,246.88	5,421,246.88	4,955,000.00	3,992,406.25	8,947,406.25	8,575,000.00	5,793,653.13	14,368,653.13			
9/30/2025										20,162,306.26	19,749,863.16	1,680,192.19
3/1/2026		1,728,846.88	1,728,846.88		3,843,756.25	3,843,756.25	-	5,572,603.13	5,572,603.13			
9/1/2026	3,765,000.00	1,728,846.88	5,493,846.88	5,205,000.00	3,843,756.25	9,048,756.25	8,970,000.00	5,572,603.13	14,542,603.13			
9/30/2026										20,115,206.26	19,729,566.32	1,676,267.19
3/1/2027		1,653,546.88	1,653,546.88		3,739,656.25	3,739,656.25	-	5,393,203.13	5,393,203.13			
9/1/2027	3,920,000.00	1,653,546.88	5,573,546.88	5,465,000.00	3,739,656.25	9,204,656.25	9,385,000.00	5,393,203.13	14,778,203.13			
9/30/2027										20,171,406.26	19,703,575.74	1,680,950.52
3/1/2028		1,594,746.88	1,594,746.88		3,630,356.25	3,630,356.25	-	5,225,103.13	5,225,103.13			
9/1/2028	4,075,000.00	1,594,746.88	5,669,746.88	5,735,000.00	3,630,356.25	9,365,356.25	9,810,000.00	5,225,103.13	15,035,103.13			
9/30/2028										20,260,206.26	19,668,786.33	1,688,350.52
3/1/2029		1,533,621.88	1,533,621.88		3,515,656.25	3,515,656.25	-	5,049,278.13	5,049,278.13			
9/1/2029	4,240,000.00	1,533,621.88	5,773,621.88	6,025,000.00	3,515,656.25	9,540,656.25	10,265,000.00	5,049,278.13	15,314,278.13			
9/30/2029										20,363,556.26	19,622,468.33	1,696,963.02
3/1/2030		1,470,021.88	1,470,021.88		3,365,031.25	3,365,031.25	-	4,835,053.13	4,835,053.13			
9/1/2030	4,415,000.00	1,470,021.88	5,885,021.88	6,325,000.00	3,365,031.25	9,690,031.25	10,740,000.00	4,835,053.13	15,575,053.13			
9/30/2030										20,410,106.26	19,566,208.48	1,700,842.19
3/1/2031		1,403,796.88	1,403,796.88		3,206,906.25	3,206,906.25	-	4,610,703.13	4,610,703.13			
9/1/2031	4,595,000.00	1,403,796.88	5,998,796.88	6,640,000.00	3,208,906.25	9,846,906.25	11,235,000.00	4,610,703.13	15,845,703.13			
9/30/2031										20,456,406.26	19,497,731.73	1,704,700.52
3/1/2032		1,332,000.00	1,332,000.00		3,040,906.25	3,040,906.25	-	4,372,906.25	4,372,906.25			
9/1/2032	4,780,000.00	1,332,000.00	6,112,000.00	6,975,000.00	3,040,906.25	10,015,906.25	11,755,000.00	4,372,906.25	16,127,906.25			
9/30/2032										20,500,812.50	19,414,141.67	1,708,401.04
3/1/2033		1,236,400.00	1,236,400.00		2,866,531.25	2,866,531.25	-	4,102,931.25	4,102,931.25			
9/1/2033	4,970,000.00	1,236,400.00	6,206,400.00	7,320,000.00	2,866,531.25	10,186,531.25	12,290,000.00	4,102,931.25	16,392,931.25			
9/30/2033										20,495,862.50	19,315,803.41	1,707,988.54
3/1/2034		1,137,000.00	1,137,000.00		2,683,531.25	2,683,531.25	-	3,820,531.25	3,820,531.25			
9/1/2034	5,225,000.00	1,137,000.00	6,362,000.00	7,690,000.00	2,683,531.25	10,373,531.25	12,915,000.00	3,820,531.25	16,735,531.25			
9/30/2034										20,556,062.50	19,191,777.50	1,713,005.21
3/1/2035		1,032,500.00	1,032,500.00		2,491,281.25	2,491,281.25	-	3,523,781.25	3,523,781.25			
9/1/2035	5,485,000.00	1,032,500.00	6,517,500.00	8,075,000.00	2,491,281.25	10,566,281.25	13,560,000.00	3,523,781.25	17,083,781.25			
9/30/2035										20,607,562.50	19,034,468.06	1,717,296.88

Dallas Bonds

9/30/2015

Dates	2012 Series- Contract Revenue Bonds (City of Dallas) Principal	Interest	Total	2014 Series- Contract Revenue Bonds (City of Dallas) Principal	Interest	Total	Total Enterprise Funds Principal	Interest	Total	Annual Payment	Avg Reserve Req after 9/1 Payment	Dallas Monthly Payments (Annual Payment / 12)
3/1/2036		922,800.00	922,800.00		2,289,406.25	2,289,406.25	-	3,212,206.25	3,212,206.25			
9/1/2036	5,765,000.00	922,800.00	6,687,800.00	8,475,000.00	2,289,406.25	10,764,406.25	14,240,000.00	3,212,206.25	17,452,206.25			
9/30/2036										20,664,412.50	18,830,725.00	1,722,034.38
3/1/2037		807,500.00	807,500.00		2,077,531.25	2,077,531.25	-	2,885,031.25	2,885,031.25			
9/1/2037	6,055,000.00	807,500.00	6,862,500.00	8,900,000.00	2,077,531.25	10,977,531.25	14,955,000.00	2,885,031.25	17,840,031.25			
9/30/2037										20,725,062.50	18,560,105.36	1,727,088.54
3/1/2038		686,400.00	686,400.00		1,855,031.25	1,855,031.25	-	2,541,431.25	2,541,431.25			
9/1/2038	6,360,000.00	686,400.00	7,046,400.00	9,345,000.00	1,855,031.25	11,200,031.25	15,705,000.00	2,541,431.25	18,246,431.25			
9/30/2038										20,787,862.50	18,188,812.50	1,732,321.88
3/1/2039		559,200.00	559,200.00		1,621,406.25	1,621,406.25	-	2,180,606.25	2,180,606.25			
9/1/2039	6,605,000.00	559,200.00	7,164,200.00	9,810,000.00	1,621,406.25	11,431,406.25	16,415,000.00	2,180,606.25	18,595,606.25			
9/30/2039										20,776,212.50	17,671,332.50	1,731,351.04
3/1/2040		427,100.00	427,100.00		1,376,156.25	1,376,156.25	-	1,803,256.25	1,803,256.25			
9/1/2040	6,855,000.00	427,100.00	7,282,100.00	10,300,000.00	1,376,156.25	11,676,156.25	17,155,000.00	1,803,256.25	18,958,256.25			
9/30/2040										20,761,512.50	16,898,787.50	1,730,126.04
3/1/2041		290,000.00	290,000.00		1,118,656.25	1,118,656.25	-	1,408,656.25	1,408,656.25			
9/1/2041	7,115,000.00	290,000.00	7,405,000.00	10,815,000.00	1,118,656.25	11,933,656.25	17,930,000.00	1,408,656.25	19,338,656.25			
9/30/2041										20,747,312.50	15,615,945.83	1,728,942.71
3/1/2042		147,700.00	147,700.00		848,281.25	848,281.25	-	995,981.25	995,981.25			
9/1/2042	7,385,000.00	147,700.00	7,532,700.00	11,360,000.00	848,281.25	12,208,281.25	18,745,000.00	995,981.25	19,740,981.25			
9/30/2042										20,736,962.50	13,055,437.50	1,728,080.21
3/1/2043	-	-	-		564,281.25	564,281.25	-	564,281.25	564,281.25			
9/1/2043		-	-	11,925,000.00	564,281.25	12,489,281.25	11,925,000.00	564,281.25	12,489,281.25			
9/30/2043										13,053,562.50	13,057,312.50	
3/1/2044	-	-	-		266,156.25	266,156.25	-	266,156.25	266,156.25			
9/1/2044		-	-	12,525,000.00	266,156.25	12,791,156.25	12,525,000.00	266,156.25	12,791,156.25			
9/30/2044										13,057,312.50	-	
3/1/2045	-	-	-			-	-	-	-			
9/1/2045		-	-			-	-	-	-			
9/30/2045										-		
3/1/2046	-	-	-			-	-	-	-			
9/1/2046		-	-			-	-	-	-			
9/30/2046										-		
3/1/2047	-	-	-			-	-	-	-			
9/1/2047		-	-			-	-	-	-			
9/30/2047										-		
3/1/2048	-	-	-			-	-	-	-			
9/1/2048		-	-			-	-	-	-			
9/30/2048										-		
3/1/2049	-	-	-			-	-	-	-			
9/1/2049		-	-			-	-	-	-			
9/30/2049										-		
3/1/2050	-	-	-			-	-	-	-			
9/1/2050		-	-			-	-	-	-			
9/30/2050										-		
3/1/2051	-	-	-			-	-	-	-			
9/1/2051		-	-			-	-	-	-			
9/30/2051										-		
3/1/2052	-	-	-	-	-	-	-	-	-			
9/1/2052		-	-		-	-	-	-	-			
9/30/2052										-		
3/1/2053	-	-	-	-	-	-	-	-	-			
9/1/2053		-	-		-	-	-	-	-			
9/30/2053										-		
Total	126,475,000.00	83,701,443.92	210,176,443.92	202,130,000.00	190,182,275.00	392,312,275.00	328,605,000.00	273,883,718.92	602,488,718.92	602,488,718.92		

Part C #49 B
TRWD

TRWD Bonds
As of 9/30/15

	2006 Series-Water Revenue Refunding and Improvement Bonds (REFUNDED FY2015)			2008A Series-TWDB WIF Program			2008B Series-TWDB WIF Program			2009 Series-Water Revenue Bonds			2010 Series-Water Revenue Bonds			2010A Series-TWDB WIF Deferred		
Dates	Principal	Interest	Total	Principal	Interest	Total	Principal	Interest	Total	Principal	Interest	Total	Principal	Interest	Total	Principal	Interest	Total
3/1/2015	-	4,264,978.13	4,264,978.13	185,000.00	33,019.50	218,019.50	-	-	-	-	1,346,125.00	1,346,125.00	-	2,076,715.63	2,076,715.63	-	-	-
9/1/2015			-		31,555.23	31,555.23		-	-		1,346,125.00	1,346,125.00		2,076,715.63	2,076,715.63		-	-
9/30/2015																		
3/1/2016				190,000.00	31,555.23	221,555.23	-	-	-	-	1,346,125.00	1,346,125.00	-	2,076,715.63	2,076,715.63	-	-	-
9/1/2016					29,908.88	29,908.88		-	-		1,346,125.00	1,346,125.00		2,076,715.63	2,076,715.63		-	-
9/30/2016																		
3/1/2017				195,000.00	29,908.88	224,908.88	-	-	-	-	1,346,125.00	1,346,125.00	-	2,076,715.63	2,076,715.63	-	-	-
9/1/2017					28,072.95	28,072.95		-	-		1,346,125.00	1,346,125.00		2,076,715.63	2,076,715.63		-	-
9/30/2017																		
3/1/2018				195,000.00	28,072.95	223,072.95	605,000.00	52,928.03	657,928.03	3,360,000.00	1,346,125.00	4,706,125.00	2,120,000.00	2,076,715.63	4,196,715.63	1,305,000.00	62,532.75	1,367,532.75
9/1/2018					26,110.28	26,110.28		46,838.70	46,838.70		1,262,125.00	1,262,125.00		2,029,015.63	2,029,015.63		180,087.98	180,087.98
9/30/2018																		
3/1/2019				200,000.00	26,110.28	226,110.28	620,000.00	46,838.70	666,838.70	3,530,000.00	1,262,125.00	4,792,125.00	2,230,000.00	2,029,015.63	4,259,015.63	1,160,000.00	180,087.98	1,340,087.98
9/1/2019					23,977.28	23,977.28		40,226.40	40,226.40		1,173,875.00	1,173,875.00		1,978,840.63	1,978,840.63		172,426.18	172,426.18
9/30/2019																		
3/1/2020				205,000.00	23,977.28	228,977.28	630,000.00	40,226.40	670,226.40	3,710,000.00	1,173,875.00	4,883,875.00	2,345,000.00	1,978,840.63	4,323,840.63	1,200,000.00	172,426.18	1,372,426.18
9/1/2020					21,551.10	21,551.10		32,770.35	32,770.35		1,081,125.00	1,081,125.00		1,920,215.63	1,920,215.63		162,880.18	162,880.18
9/30/2020																		
3/1/2021				210,000.00	21,551.10	231,551.10	645,000.00	32,770.35	677,770.35	3,900,000.00	1,081,125.00	4,981,125.00	2,465,000.00	1,920,215.63	4,385,215.63	1,235,000.00	162,880.18	1,397,880.18
9/1/2021					18,937.65	18,937.65		24,743.33	24,743.33		983,625.00	983,625.00		1,858,590.63	1,858,590.63		151,647.85	151,647.85
9/30/2021																		
3/1/2022				215,000.00	18,937.65	233,937.65	665,000.00	24,743.33	689,743.33	4,100,000.00	983,625.00	5,083,625.00	2,590,000.00	1,858,590.63	4,448,590.63	1,270,000.00	151,647.85	1,421,647.85
9/1/2022					16,171.68	16,171.68		16,188.10	16,188.10		881,125.00	881,125.00		1,793,840.63	1,793,840.63		139,049.45	139,049.45
9/30/2022																		
3/1/2023				220,000.00	16,171.68	236,171.68	680,000.00	16,188.10	696,188.10	4,315,000.00	881,125.00	5,196,125.00	2,720,000.00	1,793,840.63	4,513,840.63	1,310,000.00	139,049.45	1,449,049.45
9/1/2023					13,257.78	13,257.78		7,181.50	7,181.50		773,250.00	773,250.00		1,725,840.63	1,725,840.63		125,314.10	125,314.10
9/30/2023																		
3/1/2024				225,000.00	13,257.78	238,257.78	530,000.00	7,181.50	537,181.50	4,535,000.00	773,250.00	5,308,250.00	2,860,000.00	1,725,840.63	4,585,840.63	1,350,000.00	125,314.10	1,475,314.10
9/1/2024					10,209.03	10,209.03			-		659,875.00	659,875.00		1,668,640.63	1,668,640.63		111,199.85	111,199.85
9/30/2024																		
3/1/2025				235,000.00	10,209.03	245,209.03				4,765,000.00	659,875.00	5,424,875.00	3,010,000.00	1,668,640.63	4,678,640.63	1,390,000.00	111,199.85	1,501,199.85
9/1/2025					6,967.20	6,967.20					540,750.00	540,750.00		1,608,440.63	1,608,440.63		95,326.05	95,326.05
9/30/2025																		
3/1/2026				240,000.00	6,967.20	246,967.20				5,010,000.00	540,750.00	5,550,750.00	3,160,000.00	1,608,440.63	4,768,440.63	1,435,000.00	95,326.05	1,530,326.05
9/1/2026					3,610.80	3,610.80					415,500.00	415,500.00		1,529,440.63	1,529,440.63		78,314.13	78,314.13
9/30/2026																		
3/1/2027				255,000.00	3,610.80	258,610.80				5,265,000.00	415,500.00	5,680,500.00	3,325,000.00	1,529,440.63	4,854,440.63	1,475,000.00	78,314.13	1,553,314.13
9/1/2027					-	-		-	-		283,875.00	283,875.00		1,446,315.63	1,446,315.63		60,304.38	60,304.38
9/30/2027																		
3/1/2028		-	-	-	-	-	-	-	-	5,535,000.00	283,875.00	5,818,875.00	3,495,000.00	1,446,315.63	4,941,315.63	1,520,000.00	60,304.38	1,580,304.38
9/1/2028			-	-		-	-	-	-		145,500.00	145,500.00		1,358,940.63	1,358,940.63		41,197.98	41,197.98
9/30/2028																		
3/1/2029		-	-	-	-	-	-	-	-	5,820,000.00	145,500.00	5,965,500.00	3,675,000.00	1,358,940.63	5,033,940.63	1,570,000.00	41,197.98	1,611,197.98
9/1/2029														1,267,065.63	1,267,065.63		20,890.03	20,890.03
9/30/2029																		
3/1/2030		-	-	-	-	-	-	-	-	-	-	-	3,865,000.00	1,267,065.63	5,132,065.63	1,615,000.00	20,890.03	1,635,890.03
9/1/2030			-	-		-	-	-	-		-	-		1,170,440.63	1,170,440.63		-	-
9/30/2030																		
3/1/2031		-	-	-	-	-	-	-	-	-	-	-	4,060,000.00	1,170,440.63	5,230,440.63	-	-	-
9/1/2031			-	-		-	-	-	-		-	-		1,084,165.63	1,084,165.63		-	-
9/30/2031																		
3/1/2032		-	-	-	-	-	-	-	-	-	-	-	4,270,000.00	1,084,165.63	5,354,165.63	-	-	-
9/1/2032			-	-		-	-	-	-		-	-		977,415.63	977,415.63		-	-
9/30/2032																		
3/1/2033		-	-	-	-	-	-	-	-	-	-	-	4,490,000.00	977,415.63	5,467,415.63	-	-	-
9/1/2033			-	-		-	-	-	-		-	-		879,196.88	879,196.88		-	-
9/30/2033																		

Dates	2006 Series-Water Revenue Refunding and Improvement Bonds (REFUNDED FY2015)			2008A Series-TWDB WIF Program			2008B Series-TWDB WIF Program			2009 Series-Water Revenue Bonds			2010 Series-Water Revenue Bonds			2010A Series-TWDB WIF Deferred		
	Principal	Interest	Total	Principal	Interest	Total	Principal	Interest	Total	Principal	Interest	Total	Principal	Interest	Total	Principal	Interest	Total
3/1/2034				-	-	-	-	-	-	-	-	-	4,720,000.00	879,196.88	5,599,196.88	-	-	-
9/1/2034					-	-		-	-		-	-		772,996.88	772,996.88		-	-
9/30/2034																		
3/1/2035				-	-	-	-	-	-	-	-	-	4,960,000.00	772,996.88	5,732,996.88	-	-	-
9/1/2035					-	-		-	-		-	-		661,396.88	661,396.88		-	-
9/30/2035																		
3/1/2036				-	-	-	-	-	-	-	-	-	5,215,000.00	661,396.88	5,876,396.88	-	-	-
9/1/2036					-	-		-	-		-	-		544,059.38	544,059.38		-	-
9/30/2036																		
3/1/2037				-	-	-	-	-	-	-	-	-	5,480,000.00	544,059.38	6,024,059.38	-	-	-
9/1/2037					-	-		-	-		-	-		420,759.38	420,759.38		-	-
9/30/2037																		
3/1/2038				-	-	-	-	-	-	-	-	-	5,765,000.00	420,759.38	6,185,759.38	-	-	-
9/1/2038					-	-		-	-		-	-		287,443.75	287,443.75		-	-
9/30/2038																		
3/1/2039				-	-	-	-	-	-	-	-	-	6,060,000.00	287,443.75	6,347,443.75	-	-	-
9/1/2039					-	-		-	-		-	-		147,306.25	147,306.25		-	-
9/30/2039																		
3/1/2040				-	-	-	-	-	-	-	-	-	6,370,000.00	147,306.25	6,517,306.25	-	-	-
9/1/2040					-	-		-	-		-	-		-	-		-	-
9/30/2040																		
3/1/2041				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9/1/2041					-	-		-	-		-	-		-	-		-	-
9/30/2041																		
3/1/2042				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9/1/2042					-	-		-	-		-	-		-	-		-	-
9/30/2042																		
3/1/2043				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9/1/2043					-	-		-	-		-	-		-	-		-	-
9/30/2043																		
3/1/2044				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9/1/2044					-	-		-	-		-	-		-	-		-	-
9/30/2044																		
3/1/2045				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9/1/2045					-	-		-	-		-	-		-	-		-	-
9/30/2045																		
3/1/2046				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9/1/2046					-	-		-	-		-	-		-	-		-	-
9/30/2046																		
3/1/2047				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9/1/2047					-	-		-	-		-	-		-	-		-	-
9/30/2047																		
3/1/2048				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9/1/2048					-	-		-	-		-	-		-	-		-	-
9/30/2048																		
3/1/2049	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9/1/2049		-	-		-	-		-	-		-	-		-	-		-	-
9/30/2049																		
3/1/2050	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9/1/2050		-	-		-	-		-	-		-	-		-	-		-	-
9/30/2050																		
3/1/2051	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9/1/2051		-	-		-	-		-	-		-	-		-	-		-	-
9/30/2051																		
3/1/2052	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9/1/2052		-	-		-	-		-	-		-	-		-	-		-	-
9/30/2052																		
3/1/2053	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9/1/2053		-	-		-	-		-	-		-	-		-	-		-	-
9/30/2053																		
Total	-	4,264,978.13	4,264,978.13	2,770,000.00	493,679.22	3,263,679.22	4,375,000.00	388,824.79	4,763,824.79	53,845,000.00	25,824,125.00	79,669,125.00	89,250,000.00	68,797,747.11	158,047,747.11	17,835,000.00	2,739,809.07	20,574,809.07

TRWD Bonds
As of 9/30/15

Dates	2010B Series-TWDB WIF Construction			2012 Series- Refunding and Water Revenue			2012A Series-Water Revenue Refunding Bonds			2014 Series-Water Revenue Bonds			2015 Series-Water Revenue Bonds			Total Enterprise Funds			
	Principal	Interest	Total	Principal	Interest	Total	Principal	Interest	Total	Principal	Interest	Total	Principal	Interest	Total	Principal	Interest	Total	Annual Payment
3/1/2015	3,500,000.00	627,168.88	4,127,168.88	5,660,000.00	3,569,875.00	9,229,875.00	19,445,000.00	1,925,725.00	21,370,725.00	2,490,000.00	7,950,675.00	10,440,675.00			-	31,280,000.00	21,794,282.14	53,074,282.14	
9/1/2015		625,855.38	625,855.38		3,428,375.00	3,428,375.00		1,439,600.00	1,439,600.00		7,900,875.00	7,900,875.00		3,845,516.94	3,845,516.94	-	20,694,618.18	20,694,618.18	
9/30/2015																			73,768,900.32
3/1/2016	3,605,000.00	625,855.38	4,230,855.38	5,950,000.00	3,428,375.00	9,378,375.00	20,440,000.00	1,439,600.00	21,879,600.00		7,900,875.00	7,900,875.00	760,000.00	3,888,725.00	4,648,725.00	30,945,000.00	20,737,826.24	51,682,826.24	
9/1/2016		617,113.25	617,113.25		3,279,625.00	3,279,625.00		928,600.00	928,600.00		7,900,875.00	7,900,875.00		3,881,125.00	3,881,125.00	-	20,060,087.76	20,060,087.76	
9/30/2016																			71,742,914.00
3/1/2017	3,715,000.00	617,113.25	4,332,113.25	6,100,000.00	3,279,625.00	9,379,625.00	20,965,000.00	928,600.00	21,893,600.00		7,900,875.00	7,900,875.00	775,000.00	3,881,125.00	4,656,125.00	31,750,000.00	20,060,087.76	51,810,087.76	
9/1/2017		602,531.88	602,531.88		3,127,125.00	3,127,125.00		404,475.00	404,475.00		7,900,875.00	7,900,875.00		3,873,375.00	3,873,375.00	-	19,359,295.46	19,359,295.46	
9/30/2017																			71,169,383.22
3/1/2018	3,830,000.00	602,531.88	4,432,531.88	735,000.00	3,127,125.00	3,862,125.00	3,255,000.00	404,475.00	3,659,475.00		7,900,875.00	7,900,875.00	9,535,000.00	3,873,375.00	13,408,375.00	24,940,000.00	19,474,756.24	44,414,756.24	
9/1/2018		583,477.63	583,477.63		3,119,775.00	3,119,775.00		323,100.00	323,100.00		7,900,875.00	7,900,875.00		3,635,000.00	3,635,000.00	-	19,106,405.22	19,106,405.22	
9/30/2018																			63,521,161.46
3/1/2019	3,945,000.00	583,477.63	4,528,477.63	750,000.00	3,119,775.00	3,869,775.00	3,410,000.00	323,100.00	3,733,100.00	895,000.00	7,900,875.00	8,795,875.00	10,030,000.00	3,635,000.00	13,665,000.00	26,770,000.00	19,106,405.22	45,876,405.22	
9/1/2019		560,103.50	560,103.50		3,108,525.00	3,108,525.00		249,100.00	249,100.00		7,878,500.00	7,878,500.00		3,384,250.00	3,384,250.00	-	18,569,823.99	18,569,823.99	
9/30/2019																			64,446,229.21
3/1/2020	4,065,000.00	560,103.50	4,625,103.50	770,000.00	3,108,525.00	3,878,525.00	3,555,000.00	249,100.00	3,804,100.00	1,405,000.00	7,878,500.00	9,283,500.00	10,540,000.00	3,384,250.00	13,924,250.00	28,425,000.00	18,569,823.99	46,994,823.99	
9/1/2020		530,652.58	530,652.58		3,100,825.00	3,100,825.00		178,000.00	178,000.00		7,843,375.00	7,843,375.00		3,120,750.00	3,120,750.00	-	17,992,144.84	17,992,144.84	
9/30/2020																			64,986,968.83
3/1/2021	4,190,000.00	530,652.58	4,720,652.58	790,000.00	3,100,825.00	3,890,825.00	3,720,000.00	178,000.00	3,898,000.00	805,000.00	7,843,375.00	8,648,375.00	11,085,000.00	3,120,750.00	14,205,750.00	29,045,000.00	17,992,144.84	47,037,144.84	
9/1/2021		495,372.78	495,372.78		3,088,975.00	3,088,975.00		85,000.00	85,000.00		7,823,250.00	7,823,250.00		2,843,625.00	2,843,625.00	-	17,373,767.24	17,373,767.24	
9/30/2021																			64,410,912.08
3/1/2022	4,315,000.00	495,372.78	4,810,372.78	815,000.00	3,088,975.00	3,903,975.00	3,900,000.00	85,000.00	3,985,000.00	1,125,000.00	7,823,250.00	8,948,250.00	11,650,000.00	2,843,625.00	14,493,625.00	30,645,000.00	17,373,767.24	48,018,767.24	
9/1/2022		455,804.23	455,804.23		3,076,750.00	3,076,750.00			-		7,800,750.00	7,800,750.00		2,552,375.00	2,552,375.00	-	16,732,054.09	16,732,054.09	
9/30/2022																			64,750,821.33
3/1/2023	4,450,000.00	455,804.23	4,905,804.23	-	3,076,750.00	3,076,750.00					7,800,750.00	7,800,750.00	15,985,000.00	2,552,375.00	18,537,375.00	29,680,000.00	16,732,054.09	46,412,054.09	
9/1/2023		411,771.48	411,771.48		3,076,750.00	3,076,750.00					7,800,750.00	7,800,750.00		2,152,750.00	2,152,750.00	-	16,086,865.49	16,086,865.49	
9/30/2023																			62,498,919.58
3/1/2024	4,585,000.00	411,771.48	4,996,771.48	-	3,076,750.00	3,076,750.00					7,800,750.00	7,800,750.00	14,400,000.00	2,152,750.00	16,552,750.00	28,485,000.00	16,086,865.49	44,571,865.49	
9/1/2024		363,812.38	363,812.38		3,076,750.00	3,076,750.00					7,800,750.00	7,800,750.00		1,792,750.00	1,792,750.00	-	15,483,986.89	15,483,986.89	
9/30/2024																			60,055,852.38
3/1/2025	4,725,000.00	363,812.38	5,088,812.38	-	3,076,750.00	3,076,750.00					7,800,750.00	7,800,750.00	12,945,000.00	1,792,750.00	14,737,750.00	27,070,000.00	15,483,986.89	42,553,986.89	
9/1/2025		312,026.38	312,026.38		3,076,750.00	3,076,750.00					7,800,750.00	7,800,750.00		1,469,125.00	1,469,125.00	-	14,910,135.26	14,910,135.26	
9/30/2025																			57,464,122.15
3/1/2026	4,865,000.00	312,026.38	5,177,026.38	-	3,076,750.00	3,076,750.00					7,800,750.00	7,800,750.00	13,610,000.00	1,469,125.00	15,079,125.00	28,320,000.00	14,910,135.26	43,230,135.26	
9/1/2026		256,541.05	256,541.05		3,076,750.00	3,076,750.00					7,800,750.00	7,800,750.00		1,128,875.00	1,128,875.00	-	14,289,781.61	14,289,781.61	
9/30/2026																			57,519,916.87
3/1/2027	5,015,000.00	256,541.05	5,271,541.05	-	3,076,750.00	3,076,750.00					7,800,750.00	7,800,750.00	14,305,000.00	1,128,875.00	15,433,875.00	29,640,000.00	14,289,781.61	43,929,781.61	
9/1/2027		197,288.83	197,288.83		3,076,750.00	3,076,750.00					7,800,750.00	7,800,750.00		771,250.00	771,250.00	-	13,636,533.84	13,636,533.84	
9/30/2027																			57,566,315.45
3/1/2028	5,170,000.00	197,288.83	5,367,288.83	-	3,076,750.00	3,076,750.00					7,800,750.00	7,800,750.00	15,040,000.00	771,250.00	15,811,250.00	30,760,000.00	13,636,533.84	44,396,533.84	
9/1/2028		134,292.38	134,292.38		3,076,750.00	3,076,750.00					7,800,750.00	7,800,750.00		395,250.00	395,250.00	-	12,952,680.99	12,952,680.99	
9/30/2028																			57,349,214.83
3/1/2029	5,325,000.00	134,292.38	5,459,292.38	-	3,076,750.00	3,076,750.00					7,800,750.00	7,800,750.00	15,810,000.00	395,250.00	16,205,250.00	32,200,000.00	12,952,680.99	45,152,680.99	
9/1/2029		68,076.00	68,076.00		3,076,750.00	3,076,750.00					7,800,750.00	7,800,750.00			-	-	12,233,531.66	12,233,531.66	
9/30/2029																			57,386,212.65
3/1/2030	5,490,000.00	68,076.00	5,558,076.00	-	3,076,750.00	3,076,750.00				18,735,000.00	7,800,750.00	26,535,750.00			-	29,705,000.00	12,233,531.66	41,938,531.66	
9/1/2030		-	-		3,076,750.00	3,076,750.00					7,332,375.00	7,332,375.00			-	-	11,579,565.63	11,579,565.63	
9/30/2030																			53,518,097.29
3/1/2031	-	-	-	6,450,000.00	3,076,750.00	9,526,750.00				20,355,000.00	7,332,375.00	27,687,375.00			-	30,865,000.00	11,579,565.63	42,444,565.63	
9/1/2031		-	-		2,915,500.00	2,915,500.00					6,823,500.00	6,823,500.00			-	-	10,823,165.63	10,823,165.63	
9/30/2031																			53,267,731.26
3/1/2032	-	-	-	6,750,000.00	2,915,500.00	9,685,500.00				21,145,000.00	6,823,500.00	27,968,500.00			-	32,165,000.00	10,823,165.63	42,988,165.63	
9/1/2032		-	-		2,755,500.00	2,755,500.00					6,294,875.00	6,294,875.00			-	-	10,027,790.63	10,027,790.63	
9/30/2032																			53,015,956.26
3/1/2033	-	-	-	7,065,000.00	2,755,500.00	9,820,500.00				21,980,000.00	8,294,875.00	28,274,875.00			-	33,535,000.00	10,027,790.63	43,562,790.63	
9/1/2033		-	-		2,578,875.00	2,578,875.00					5,745,375.00	5,745,375.00			-	-	9,203,446.88	9,203,446.88	
9/30/2033																			52,766,237.51

	2010B Series-TWDB WIF Construction			2012 Series- Refunding and Water Revenue			2012A Series-Water Revenue Refunding Bonds			2014 Series-Water Revenue Bonds			2015 Series-Water Revenue Bonds			Total Enterprise Funds			
Dates	Principal	Interest	Total	Principal	Interest	Total	Principal	Interest	Total	Principal	Interest	Total	Principal	Interest	Total	Principal	Interest	Total	Annual Payment
3/1/2034	-	-	-	7,375,000.00	2,578,875.00	9,953,875.00				22,880,000.00	5,745,375.00	28,625,375.00			-	34,975,000.00	9,203,446.88	44,178,446.88	
9/1/2034		-	-		2,394,500.00	2,394,500.00					5,173,375.00	5,173,375.00			-	-	8,340,871.88	8,340,871.88	
9/30/2034																			52,519,318.76
3/1/2035	-	-	-	7,725,000.00	2,394,500.00	10,119,500.00				9,495,000.00	5,173,375.00	14,668,375.00			-	22,180,000.00	8,340,871.88	30,520,871.88	
9/1/2035		-	-		2,201,375.00	2,201,375.00					4,936,000.00	4,936,000.00			-	-	7,798,771.88	7,798,771.88	
9/30/2035																			38,319,643.76
3/1/2036	-	-	-	8,070,000.00	2,201,375.00	10,271,375.00				9,980,000.00	4,936,000.00	14,916,000.00			-	23,265,000.00	7,798,771.88	31,063,771.88	
9/1/2036		-	-		1,999,625.00	1,999,625.00					4,686,500.00	4,686,500.00			-	-	7,230,184.38	7,230,184.38	
9/30/2036																			38,293,956.26
3/1/2037	-	-	-	8,445,000.00	1,999,625.00	10,444,625.00				10,490,000.00	4,686,500.00	15,176,500.00			-	24,415,000.00	7,230,184.38	31,645,184.38	
9/1/2037		-	-		1,788,500.00	1,788,500.00					4,424,250.00	4,424,250.00			-	-	6,633,509.38	6,633,509.38	
9/30/2037																			38,278,693.76
3/1/2038	-	-	-	-	1,788,500.00	1,788,500.00				11,030,000.00	4,424,250.00	15,454,250.00			-	16,795,000.00	6,633,509.38	23,428,509.38	
9/1/2038		-	-		1,788,500.00	1,788,500.00					4,148,500.00	4,148,500.00			-	-	6,224,443.75	6,224,443.75	
9/30/2038																			29,652,953.13
3/1/2039	-	-	-	-	1,788,500.00	1,788,500.00				11,595,000.00	4,148,500.00	15,743,500.00			-	17,655,000.00	6,224,443.75	23,879,443.75	
9/1/2039		-	-		1,788,500.00	1,788,500.00					3,858,625.00	3,858,625.00			-	-	5,794,431.25	5,794,431.25	
9/30/2039																			29,673,875.00
3/1/2040	-	-	-	-	1,788,500.00	1,788,500.00				12,190,000.00	3,858,625.00	16,048,625.00			-	18,560,000.00	5,794,431.25	24,354,431.25	
9/1/2040		-	-	-	1,788,500.00	1,788,500.00					3,553,875.00	3,553,875.00			-	-	5,342,375.00	5,342,375.00	
9/30/2040																			29,696,806.25
3/1/2041	-	-	-	4,460,000.00	1,788,500.00	6,248,500.00				12,815,000.00	3,553,875.00	16,368,875.00			-	17,275,000.00	5,342,375.00	22,617,375.00	
9/1/2041		-	-		1,677,000.00	1,677,000.00					3,233,500.00	3,233,500.00			-	-	4,910,500.00	4,910,500.00	
9/30/2041																			27,527,875.00
3/1/2042	-	-	-	4,690,000.00	1,677,000.00	6,367,000.00				13,470,000.00	3,233,500.00	16,703,500.00			-	18,160,000.00	4,910,500.00	23,070,500.00	
9/1/2042		-	-		1,559,750.00	1,559,750.00					2,896,750.00	2,896,750.00			-	-	4,456,500.00	4,456,500.00	
9/30/2042																			27,527,000.00
3/1/2043	-	-	-	4,930,000.00	1,559,750.00	6,489,750.00				14,160,000.00	2,896,750.00	17,056,750.00			-	19,090,000.00	4,456,500.00	23,546,500.00	
9/1/2043		-	-		1,436,500.00	1,436,500.00					2,542,750.00	2,542,750.00			-	-	3,979,250.00	3,979,250.00	
9/30/2043																			27,525,750.00
3/1/2044	-	-	-	5,185,000.00	1,436,500.00	6,621,500.00				14,890,000.00	2,542,750.00	17,432,750.00			-	20,075,000.00	3,979,250.00	24,054,250.00	
9/1/2044		-	-		1,306,875.00	1,306,875.00					2,170,500.00	2,170,500.00			-	-	3,477,375.00	3,477,375.00	
9/30/2044																			27,531,625.00
3/1/2045	-	-	-	5,450,000.00	1,306,875.00	6,756,875.00				15,650,000.00	2,170,500.00	17,820,500.00			-	21,100,000.00	3,477,375.00	24,577,375.00	
9/1/2045		-	-		1,170,625.00	1,170,625.00					1,779,250.00	1,779,250.00			-	-	2,949,875.00	2,949,875.00	
9/30/2045																			27,527,250.00
3/1/2046	-	-	-	5,730,000.00	1,170,625.00	6,900,625.00				16,455,000.00	1,779,250.00	18,234,250.00			-	22,185,000.00	2,949,875.00	25,134,875.00	
9/1/2046		-	-		1,027,375.00	1,027,375.00					1,367,875.00	1,367,875.00			-	-	2,395,250.00	2,395,250.00	
9/30/2046																			27,530,125.00
3/1/2047	-	-	-	6,025,000.00	1,027,375.00	7,052,375.00				17,330,000.00	1,367,875.00	18,697,875.00			-	23,355,000.00	2,395,250.00	25,750,250.00	
9/1/2047		-	-		876,750.00	876,750.00					934,625.00	934,625.00			-	-	1,811,375.00	1,811,375.00	
9/30/2047																			27,561,625.00
3/1/2048	-	-	-	6,330,000.00	876,750.00	7,206,750.00				18,220,000.00	934,625.00	19,154,625.00			-	24,550,000.00	1,811,375.00	26,361,375.00	
9/1/2048		-	-		718,500.00	718,500.00					479,125.00	479,125.00			-	-	1,197,625.00	1,197,625.00	
9/30/2048																			27,559,000.00
3/1/2049	-	-	-	6,655,000.00	718,500.00	7,373,500.00				19,165,000.00	479,125.00	19,644,125.00			-	25,820,000.00	1,197,625.00	27,017,625.00	
9/1/2049		-	-		552,125.00	552,125.00						-			-	-	552,125.00	552,125.00	
9/30/2049																			27,569,750.00
3/1/2050	-	-	-	6,995,000.00	552,125.00	7,547,125.00										6,995,000.00	552,125.00	7,547,125.00	
9/1/2050		-	-		377,250.00	377,250.00										-	377,250.00	377,250.00	
9/30/2050																			7,924,375.00
3/1/2051	-	-	-	7,355,000.00	377,250.00	7,732,250.00										7,355,000.00	377,250.00	7,732,250.00	
9/1/2051		-	-		193,375.00	193,375.00										-	193,375.00	193,375.00	
9/30/2051																			7,925,625.00
3/1/2052	-	-	-	7,735,000.00	193,375.00	7,928,375.00										7,735,000.00	193,375.00	7,928,375.00	
9/1/2052		-	-		-	-										-	-	-	
9/30/2052																			7,928,375.00
3/1/2053	-	-	-	-	-	-										-	-	-	
9/1/2053		-	-		-	-										-	-	-	
9/30/2053																			-
Total	70,790,000.00	13,056,608.34	83,846,608.34	144,990,000.00	169,248,825.00	314,238,825.00	78,690,000.00	9,141,475.00	87,831,475.00	318,750,000.00	387,823,175.00	706,573,175.00	156,470,000.00	69,735,241.94	226,205,241.94	937,765,000.00	751,514,488.60	1,689,279,488.60	1,689,279,488.60

Part D: Project information

54. Project Description

Tarrant Regional Water District (TRWD) and the City of Dallas (DWU) have partnered to finance, plan, design construct and operate the Integrated Pipeline (IPL) Project. The IPL Project is an integrated water delivery transmission system connecting Lake Palestine to Lake Benbrook with additional connections to Cedar Creek and Richland-Chambers Reservoirs and interconnections to TRWD's existing pipelines that creates flexibility in delivery as well as quick response to fluctuating customer water demands. The IPL Project consists of 150 miles of pipeline, three new lake pump stations, and three new booster pump stations delivering a required capacity of 350 million gallons per day (MGD) of raw water to North Central Texas. TRWD and DWU currently serve over 4.1 million residents and the IPL will allow these agencies to continue supporting regional community and economic growth. The funding in this bond issue would pay for multiple sections of the pipeline, a lake pump station, a booster pump station, high voltage power, communications transmission infrastructure, project related soft costs, issuance costs and a reserve fund.

The IPL Project is planned and designed for a five phase sequence of construction. Phases 1 and 2 are scheduled to be constructed and operational by the first quarter of 2020. Phases 3, 4 and 5 are TRWD and Dallas demand and/or future source availability dependent and, therefore, may not be initiated in the numerical sequential order shown. If approved, the Texas Water Development Board Financial Assistance funds will be applied to projects in Phases 1 and 2. Following are the primary IPL system components and their associated construction sequences --

1. **Phase 1 -- RCPL Interconnect to RCCCPL Interconnect**
    a. **Pipeline Section 15-1 --** 15.49-miles x 108-inch pipe
    b. **Joint Booster Pump Station 3 (JB3) Reservoirs --** 2 each, 40-million gallon reservoirs
    c. **Pipeline Sections 12 and 13 and Midlothian Balancing Reservoir --** 13.62-miles x 108-inch pipe and 3 each 133.3-million gallon reservoirs
    d. **Joint Booster Pump Station 4 (JB4) Interconnect to Section 12 --** .25-miles (1,332-feet) x 108-inch pipe
    e. **Richland Chambers Cedar Creek Section 12 (RCCC) Interconnect --** 350-MGD control facility splits flow between TRWD and DWU
    f. **Section 12 Dallas Water Utilities Outlet Connection** -- IPL to DWU interconnection
    g. **IPL Microwave Communications --** Control communications network
    h. **SCADA Installation and Application Engineering --** Expansion of existing SCADA system to include IPL phases 1 and 2
    i. **Joint Booster Pump Station 3 (JB3) --** 350-MGD low capacity booster pump station
    j. **Joint Booster Pump Station (JB3) Electrical Substation --** 138-kV, 46-MVA electric substation
    k. **Pipeline Section 15-2 --** 13.22-miles x 108-inch pipe
    l. **Pipeline Section 14 --** 15.1-miles x 108-inch pipe
    m. **Owner Furnished Equipment re: Richland Chambers Interconnect Valves --**12-each 42-inch butterfly valves
    n. **Owner Furnished Equipment re:** Mainline and Reservoir Gate Valves -- 5-each -- 108-inch isolation gate valves
    o. **Owner Furnished Equipment re: Mainline and Reservoir Butterfly Valves --** 4-each 60-inch and 6-each 108-inch mainline isolation butterfly valves
    p. **Owner Furnished Equipment re: JB3 Isolation Butterfly Valves --** 7-each 54-inch and 3-each 108-inch JB3 isolation butterfly valves

q. **Owner Furnished Equipment re: RCCC Interconnect Control Valves --** 2-each 60-inch multi-orifice valves
r. **Owner Furnished Equipment re: JB3 Pumps, Motors, Drives --** 5-each pump, motor, and drive assemblies

2. Phase 2 – Joint Cedar Creek Lake Pump Station and Kennedale Balancing Reservoir Connections

a. **Pipeline Sections 10 and 11 --** 12.31-miles x 84-inch pipe
b. **Joint Booster Pump Station 4 (JB4) By Pass to Section 11** -- .38-miles (1,990-feet) x 84-inch pipe
c. **Section 10 Pressure Reducing Station --** 200-MGD pressure control interconnect station
d. **Pipeline Section 17 Trinity River Tunnel --** .682- miles (3,600-feet) x 108-inch finished tunnel
e. **Pipeline Sections 17 and 18 --** 9.04-miles x 108-inch pipe
f. **Joint Booster Pump station 2 (JB2) Bypass --** 1.04-miles x 108-inch pipe
g. Joint Cedar Creek Lake Pump Station (JCC1) Intake and Wetwell **--** 277-MGD lake intake and wetwell
h. **Joint Cedar Creek Lake Pump Station (JCC1) --** 277-MGD lake pump station
i. **Joint Cedar Creek Lake Pump Station (JCC1) Electrical Substation --** 138-kV, 27-MVA electric substation
j. **Owner Furnished Equipment re: JCC1 Ball Valves --** 5-each 36-inch and 18-inch pump control valves
k. **Owner Furnished Equipment re: JCC1 and Mainline Isolation Gate Valves --** 2-each 108-inch isolation gate valves
l. **Owner Furnished Equipment re: JCC1 Pumps, Motors, Drives --** 7-each pump, motor, and drive assemblies

Phase 3 -5 Construction timing to be determined at a later date based on demands

3. Phase 3 -- Lake Palestine Connection

a. **Pipeline Section 19-1 --** 20.73-miles x 84-inch pipe
b. **Pipeline Section 19-2 --** 20.94-miles x 84-inch pipe
c. **Lake Palestine Pump Station (LP1) Intake and Wetwell --** 150-MGD lake intake and wetwell
d. **Lake Palestine Pump Station (LP1) --** 150-MGD lake pump station
e. **Lake Palestine Pump Station (LP1) Electrical Substation --** 138-kV, 23-MVA electric substation
f. **Joint Booster Pump Station 2 (JB2) Reservoirs –** 2-each, 40-million gallon reservoirs
g. **Joint Booster Pump Station 2 (JB2) --** 350-MGD high capacity booster pump station
h. **Joint Booster Pump Station (JB2) Electrical Substation --** 138-kV, 41-MVA electric substation

4. Phase 4 -- Richland Chambers Reservoir Connection

a. **Pipeline Section 16 --** 12.31-miles x 96-inch pipe
b. **Joint Richland Chambers Lake Pump Station (JRC1) Intake and Wetwell --** 250-MGD lake intake and wetwell
c. **Joint Richland Chambers Lake Pump Station (JRC1)** -- 250-MGD lake pump station
d. **Joint Richland Chambers Lake Pump Station (JRC1) Electrical Substation --** 138-kV, 20-MVA electric substation

5. Phase 5 -- Lake Benbrook Connection

a. **Pipeline Section 9 --** 10.71-miles x 84-inch pipe
b. **Pipeline Section 9 Deep Tunnel --** 5.0-miles x 120-inch finished tunnel

c. **Joint Booster Pump Station 4 (JB4) --** 200-MGD high capacity booster pump station
d. **Joint Booster Pump Station 4 (JB4) Electrical Substation --** 138-kV, 20-MVA electric substation

6. Alternatives Considered –

Several component alternatives were considered and evaluated during the course of IPL project planning, development, and design that focused on operational efficiency, service life, reliability/redundancy, sustainability, and life cycle cost. Several system configuration/component alternative considerations are --

a. **Integrated Pipeline –** TRWD and Dallas joint pipeline with dual service capability versus TRWD and Dallas independent pipelines re: joint or shared capital and life cycle cost savings
b. **Pipeline right-of-way (ROW) –** build the IPL in existing TRWD ROW versus new ROW re: system security and reliability.
c. **Electric Transmission Power Grids –** greater system reliability and redundancy with IPL booster pump stations on alternate circuits from existing TRWD booster stations
d. **Lake Pump Station Intakes and Wetwells –** improved hydraulic performance and efficiency and biofilm and mussel control
e. **Booster Pump Stations** – three boosters versus two boosters allows for more efficient IPL operations, phasing based on demands and future source locations
f. **Booster Suction Reservoirs –** earthen reservoirs versus tanks provide additional volume for IPL system recovery/adjustments following power outages and normal operation time of day pumping (energy efficiency)
g. **Variable Frequency Drives (VFD) –** all pump units equipment with VFDs versus across-the-line start improves energy efficiency, reduces energy cost, and essential for effective time-of-day delivery
h. **Pipeline Alignment and Profile –** deep tunnels versus open cuts yields improved hydraulic performance (gravity) and energy reduction
i. **Pipeline Friction Factor and Diameter–** increased system life cycle efficiency
j. **Midlothian Balancing Reservoir –** Provides time-of-day delivery capability and water treatment plant contingency/emergency supply during IPL outages

Tarrant Regional Water District/ City of Dallas

Amendments 3 and 4 of Phase 1 of the Raw Water Transmission System Integration Study Report No. 3

July 2010

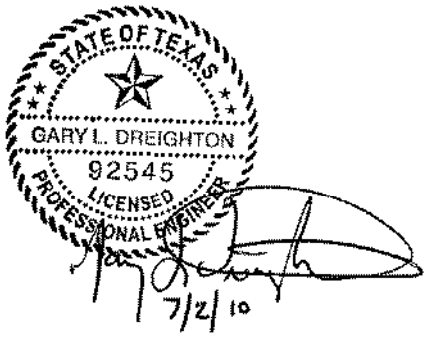
CDM In Association with: FREESE AND NICHOLS

Geo-Marine, Inc.

Tarrant Regional Water District/ City of Dallas

Amendments 3 and 4 of Phase 1 of the Raw Water Transmission System Integration Study Report No. 3

July 2010



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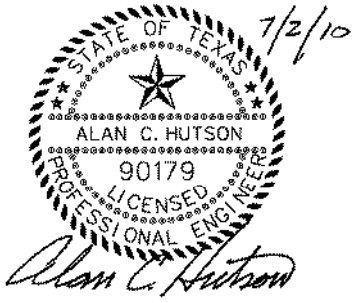

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Geo-Marine, Inc.

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Executive Summary

ES 1 Background and Purpose

The Tarrant Regional Water District (TRWD) and the City of Dallas have partnered to explore the feasibility of an integrated approach to bring additional water into the Dallas and Tarrant Regional Water District service areas. This project's planning level phase, the "Raw Water Transmission System Integration Study: Phase 1", is completed with this final report. It has been a business case evaluation and project viability assessment, meaning that it is focused on identifying fatal flaws (if present) and comparing independent projects to system integration. Because the project has been found viable and the business case sufficiently strong to recommend system integration, Dallas and TRWD intend to enter into an agreement to share conveyance infrastructure and water and begin the design and construction process.

Part of the Integrated Pipeline (IPL) Project planning phase is selection of a pipeline route (a pipeline centerline with a roughly 450' buffer based primarily on desktop analysis methods). Pipeline alignment planning is based on an engineering assessment typically broken down into (3) phases: Corridor Selection, Route Selection, and Alignment Selection. Each phase of study is progressively more detailed as one moves from the corridor selection phase to the alignment selection phase. This process helps identify the pipeline alignment that best meets performance criteria established by the Owner and design team, meets requirements of the NEPA (National Environmental Policy Act) process, and refines project definition on a path parallel to other project planning. This study represents the Route Selection phase of that process.

The purpose of this draft report is to present the final recommended pipeline route and preliminary facility sites (pending full operations study) for the Integrated Pipeline project (IPL). The selected pipeline route will be refined to a final alignment in the next phase of work, which will also include a full Operations Study that will finalize selection of facility sites.

Because Dallas is reviewing multiple alternatives to bring water into their system from the IPL (see *Dallas Delivery Location Analysis* Technical Memoranda), this report does not analyze, cost, or recommend a pipeline route for Segment H, the connection between the IPL and Dallas' delivery point. However, project cost including Segment H is included in Appendix M only for reference purposes and is not included elsewhere in the report.

The overall Integrated Pipeline has been subdivided into reaches, designated A through I; the recommended pipeline route is shown in **Figure ES-1** and **Table ES-1** provides segment descriptions and design flow rates. Segments were defined based on the proposed design flow rate of the pipe and based on cost allocation methodologies described in the October 2009 *Amendments 3 and 4 of Phase 1 of the Raw Water Transmission System Integration Study Report No. 1*.

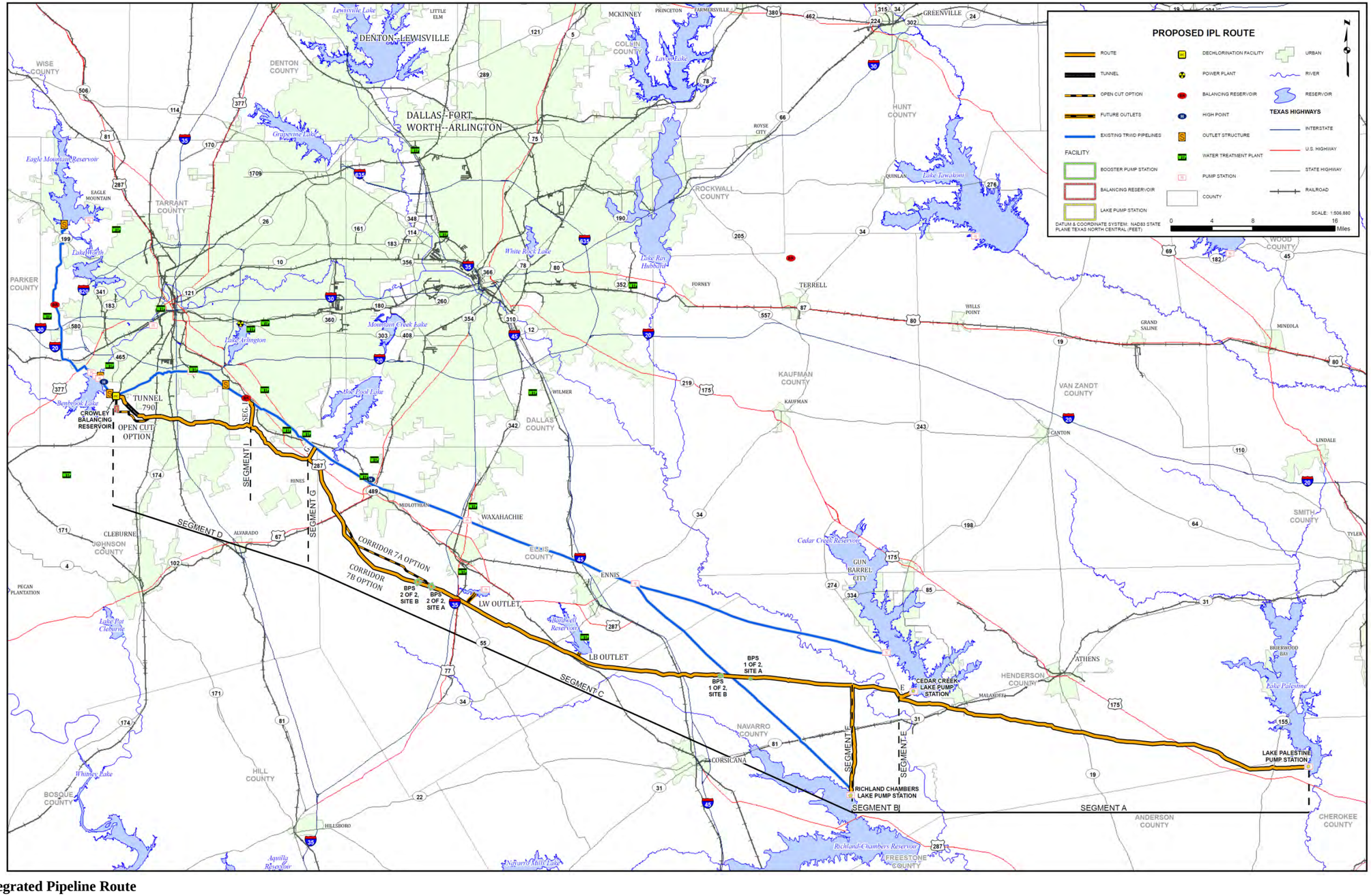

Figure ES-1. Integrated Pipeline Route

Pumping facilities selected for the Integrated Pipeline consist of three new intake pump stations (Lake Palestine Intake, Cedar Creek Intake, and Richland-Chambers Intake) and two booster pump stations as shown in Figure ES-1 above.

Table ES-1 Segment Descriptions

Segment	From	To	Design Flow Rate (MGD)	Potential Cost Allocation
A	Lake Palestine	Cedar Creek Connection	150	100% Dallas[1]
B	Cedar Creek Connection	Richland-Chambers Connection	277	Joint
C	Richland-Chambers Connection	Bachman Take-off Point	347	Joint
D	Bachman Take-off Point	Connection to Benbrook Pipeline	197	100% TRWD
E	Cedar Creek Reservoir	Connection to the Main Pipeline	127	100% TRWD
F	Richland Chambers	Connection to the Main Pipeline	70	100% TRWD
G	Main Pipeline	Existing TRWD Lines	347	Joint
I	Connection to Main Pipeline	Kennedale Balancing Reservoir	197	100% TRWD

In order to keep the main report body more concise, many of the analyses supporting pipeline route selection are contained in the appendices. The main report is structured as follows:

- Section 1 – Introduction
- Section 2 – Route Selections and Descriptions
- Section 3 – Facility Site Selection (lake pump stations and booster pump stations)
- Section 4 – Hydraulic Evaluation
- Section 5 – Costs
- Section 6 – Recommendations
- Section 7 – References

Appendices contain results of the following studies that support the evaluation of corridors:

- Integrated vs. Independent Project Costs
- Conflict Analysis
- Route Maps
- Phasing Analysis (in draft outline form as of the date of this draft report submittal)

Several workshops, technical memoranda and reports were used to help develop the recommendations noted in this report. Some of these documents are listed below:

- Amendments 3 and 4 of Phase 1 of the Raw Water Transmission System Integration Study Report No. 1.
- Amendments 3 and 4 of Phase 1 of the Raw Water Transmission System Integration Study Report No. 2.

[1] Under the existing form of the Team Charter, TRWD will share only in the cost for purchase of additional right of way in this segment.

- Corridor Selection Criteria Technical Memorandum
- Hydraulic Design Criteria Technical Memorandum
- Infrastructure Sizing Technical Memorandum
- Southern Re-route (Corridor 7) Comparison Technical Memorandum

ES 2 Recommendations and Conclusions

- Using primarily desktop analysis methods, this analysis recommends the pipeline route and facility sites as shown in Figure ES-1
- It is recommended that a 2 Booster Pump Station configuration be selected at this time for refinement and verification during the Conceptual Design and Operations Study phase.
- This report recommends that a deep tunnel be constructed through the Benbrook high point (near Crowley) for reasons of life-cycle cost reduction through pumping energy savings. This recommendation will also be refined and verified during the Conceptual Design and Operations Study phase.
- The following pipe sizes are recommended based on current system operations modeling:

Segment	***Design Flow***	***Nominal Pipe Size***
	(MGD)	***(Inch)***
A	150	84
B	277	108
C	347	108
D	197	84
E	127	72
F	70	66
G	347	108
H	150	84
I	197	84

- Current cost analyses conclude that significant cost savings will be realized by developing an integrated raw water transmission system as compared to developing independent systems, savings in the range of $375 to $443 million in capital cost and roughly $1 to $1.5 billion in present worth 50-year life-cycle cost.
- Total project (without Segment H) capital costs using the recommended pipeline route and current configuration is approximately $1.47 billion (in 2009 dollars). 100-year life-cycle present worth is approximately $3 billion.
- The detailed cost spreadsheets and tables noted in this report have been validated by the 0% Value Engineering (VE) team. Most of the recommendations and cost estimating methodology suggestions were adopted and incorporated into this final report subsequent to the VE workshops held during the week of May 17, 2010. However, because some analyses were completed prior to the VE, many comparative cost estimates rely on older

methodology. This is most evident in the appendices, which contain results from analyses completed prior to the VE.

ES 3 Next Steps

This report concludes the planning phase of the Raw Water Transmission System Integration Study and leads into the conceptual design phase of the Integrated Pipeline Project. The following next steps are recommended.

With the conclusion of this route selection, the pipeline analysis will transition from a desktop route study to a final surveyed alignment which will be used in the final design of all segments. To date, the corridor and route studies have been primarily "desktop" studies using aerial photography, available records and databases, and readily available property data. In order to refine the route to the final alignment, significant field work, survey, landowner research, engineering, environmental, and archeological research, will be required.

A full Operations Study will accompany pipeline routing and facility site selection in the conceptual design phase. This study will define system operations, hydraulics, and component operations under a variety of operating conditions, such as seasonal variations in water demand, maintenance and contingency operations, and etc. This operations study and accompanying cost analysis will refine and either verify or modify recommendations made in this report, which were based on one set of baseline operating conditions.

Project design standards are currently under development and will also be finalized in the subsequent project phase. These standards will be the basis for final design.

Section 1
Introduction and Purpose

1.1 Project Background

The Tarrant Regional Water District (TRWD) and the City of Dallas have partnered to explore the feasibility of an integrated approach to bring additional water into the Dallas and Tarrant Regional Water District service areas. This project's planning level phase, the "Raw Water Transmission System Integration Study: Phase 1", is completed with this final report. It has been a business case evaluation and project viability assessment, meaning that it is focused on identifying fatal flaws (if present) and comparing independent projects to system integration. Because the project has been found viable and the business case sufficiently strong to recommend system integration, Dallas and TRWD intend to enter into an agreement to share conveyance infrastructure and water and begin the design and construction process.

Part of the Integrated Pipeline (IPL) Project planning phase is selection of a pipeline route. This work was completed in two steps. The first step was to select facility (pump stations, outlets, tanks, etc.) sites and a pipeline corridor, defined as a pipeline centerline with a ½ mile buffer on either side within which the final pipeline will be constructed. This report describes the analysis to refine the pipeline corridor to a route, a pipeline centerline within the corridor with a smaller buffer and greater certainty, though still based on desktop analysis methods. During the corridor selection phase of the project, several corridor alignments were compared based upon 5 principal criteria:

- Schedule
- Environmental Constraints
- Cost (capital, energy, and life cycle)
- Constructability
- Performance (hydraulic, operational)

A comparative analysis of multiple corridors was developed and presented in *Amendments 3 and 4 of Phase 1 of the Raw Water Transmission System Integration Study Report No. 2.* After the submittal and review of Report No. 2, an additional corridor was identified as a viable alternative. The IPL team prepared an additional comparative analysis between the newly defined corridor (Corridor 7) and the corridor recommended and selected in Report No. 2 (Corridor 1/5 hybrid).

A workshop meeting was held on March 16, 2010 to make four decisions: 1) select the final preferred corridor; 2) select the number of booster pump stations; 3) recommend the lowest life-cycle cost pipe size; and 4) decide if deep tunnels would be constructed through Midlothian and/or the Crowley portions of the pipeline. Decisions on items 1 through 4 were made during the meeting with an understanding that decisions 2 through 4 will require confirmation during the operations study in the next phase of the IPL project.

In that meeting, comparisons between Corridor 1/5 hybrid and Corridor 7 were made based on the five principal criteria described above and Corridor 7b was selected as the preferred corridor. Environmental reconnaissance helicopter flights along the selected corridor began the following week and all cost estimates, hydraulic calculations and other relevant tasks moved forward based on the alignment of Corridor 7b.

1.2 Report Purpose and Overview

The overall Integrated Pipeline has been subdivided into reaches (designated A through I and as shown in **Figure 1-1**) depending on the proposed design flow rate of the pipe and based on cost allocation methodologies described in the October 2009 *Amendments 3 and 4 of Phase 1 of the Raw Water Transmission System Integration Study Report No. 1*.

The purpose of this report is to present the final recommended pipeline route and preliminary facility sites (pending full operations study) for the Integrated Pipeline project (IPL). The selected pipeline route will be refined to a final alignment in the next phase of work, which will also include a full Operations Study that will finalize selection of facility sites.

Because Dallas is reviewing multiple alternatives to bring water into their system from the IPL (see *Dallas Delivery Location Analysis* Technical Memoranda), this report does not analyze, cost, or recommend a pipeline route for Segment H, the connection between the IPL and Dallas' delivery point.

In order to keep the main report body more concise, much of the analyses supporting pipeline route are contained in the appendices. The main report is structured as follows:

- Section 1 – Introduction
- Section 2 – Route Selection and Descriptions: The purpose of this section is to describe the pipeline segments of the IPL route.
- Section 3 – Facility Site Selection: Preliminary facility site selections are discussed in this section of the report; including lake pump stations, booster pump stations, storage tanks, and outlet structures.
- Section 4 – Hydraulic Modeling: Prior assessments focused on the existing transmission system as well as the proposed (integrated system). Peak capacities of the proposed transmission pipeline were established along with general alignment corridors. This section focuses on the selected IPL configuration for peak flow conditions including sizing of the pipelines and capacity/power requirements for the pumping stations. Specific routes and pump station locations have been identified and facility sizing has been established for the IPL route. This section also addresses hydraulic criteria, analysis tools and approach associated with selected IPL configuration.
- Section 5 – Costs: This section describes the main IPL project cost analysis and the current basis for the conceptual level opinion of probable capital cost and life cycle cost. Project milestones such as the conceptual and final design will generate more detail so that estimates improve as project definition improves. This section first describes parameters used in the cost analysis and its methodology. Next, capital cost estimates are summarized for each segment and facility, followed by life-cycle cost estimates.

- Section 6 – Summary of Selected Route: This section of the report provides a comprehensive tabular view of the main IPL route and the quantitative and qualitative descriptive fields associated with the IPL configuration.
- Section 7 – References: This section includes a comprehensive list of references cited in the report.

Appendices contain results of the following studies that support the selection of the IPL route:

- Redundancy Study and Potential Power Suppliers
- Geology and Geotechnical Considerations
- Environmental and Cultural Resources Analysis
- Permitting Inventory
- Infrastructure Sizing
- Cost Spreadsheets
- Risk Analysis
- Preliminary Surge Analysis
- Route Maps
- Integrated vs. Independent Project Costs
- Conflict Analysis
- Route Maps
- Phasing Analysis
- Project Opinion of Probable Cost including Segment H

1.3 Methodology

Selection of the IPL pipeline route and facility sites began with a pipeline corridor selection, detailed in *Amendments 3 and 4 of Phase 1 of the Raw Water Transmission System Integration Study Report No. 2*. Report 2 presented multiple pipeline corridor options and the final preferred corridor was selected based on a methodology described in Sections 7 and 8 of that report. Starting with the final selected corridor, a detailed desktop conflict analysis addressing qualitative and quantitative factors was used to select the preferred IPL route, a refinement to the roughly one-half mile wide corridor. Details of the conflict analysis are noted in Appendix J of this report.

1.4 Key Terms

Alignment: here defined as a final pipeline centerline that will be used in construction bid packages. This will be defined in conceptual design and may be slightly refined throughout the final design phases.

Corridor: here defined as a pipeline centerline with a ½ mile buffer on either side within which the final pipeline will be constructed, selected based on primarily desktop analyses..

Criteria/Evaluation Criteria: here defined as the standard by which the corridors are ranked based on project objectives.

Integrated Pipeline: The raw water transmission system integrating TRWD and Dallas supply transmission from Lake Palestine and Cedar Creek and Richland-Chambers Reservoirs.

Route: here defined as a pipeline centerline within the corridor with a smaller buffer and greater certainty than a corridor, though still based on primarily desktop analysis methods

Section 2
Route Selection and Descriptions

This section describes the recommended pipeline route for the Integrated Pipeline Project (IPL). The section is divided into 8 parts that describe Segments A through I plus a final part that describes next steps in the process. Dallas' branch line to their delivery point at either Bachman Lake or Joe Pool Lake, defined as Segment H, will not be discussed in this draft report as the final delivery point has not been determined at this time. Segment G is evaluated here but this Segment may be eliminated in future studies depending on the Dallas delivery location and results from the full operations study in the next phase of work.

For purposes of the analysis, the pipeline was divided into various pipeline segments depending on the proposed design flow rate of the pipe and in consideration of potential ownership and cost allocations between TRWD and Dallas. The **Table 2-1** lists the various pipeline segments and design flow rates. Pipe diameters as listed here and referenced hereafter are pending full Operations Study results to set their final diameters.

Table 2-1. IPL Segment Descriptions with Anticipated Pipeline Diameter, Design Flow Fate and Cost Allocation

Segment	From	To	Pipeline Diameter	Flow Rate (MGD)	Potential Cost Allocation
A	Lake Palestine	Cedar Creek Connection	84"	150	100% DWU[1]
B	Cedar Creek Connection	Richland-Chambers Connection	108"	277	Joint
C	Richland-Chambers Connection	Bachman Take-off Point	108"	347	Joint
D	Bachman Take-off Point	Connection to Benbrook Pipeline	84"	197	100% TRWD
E	Cedar Creek Reservoir	Connection to the Main Pipeline	72"	127	100% TRWD
F	Richland-Chambers	Connection to the Main Pipeline	66"	70	100% TRWD
G	Main Pipeline	Existing TRWD Lines	108"	347	Joint
H	Existing TRWD Lines	Bachman WTP	84"	150	100% DWU
I	KBR Take-off Point from Main Pipeline	Kennedale Balancing Reservoir	84"	197	100% TRWD

The route was selected on the best information available to the route selection team without the benefit of accessing property or talking with various entities with jurisdiction along the pipeline route. A route width of 450 feet wide was selected to bracket the landowners that would be contacted for survey access permission. Once the property is accessible, this 450 foot buffer on the route centerline will be cleared for environmental and archeological conflicts. Engineering evaluations and discussions with landowners may bring about the need to deviate the pipeline from the current route centerline. The goal will be to remain in the 450 foot wide buffer;

[1] Under the existing form of the Team Charter, TRWD will share only in the cost for purchase of additional right of way in this segment.

however, it is anticipated that some additional areas will require access permission and environmental clearance.

Mapping

A map of the pipeline route with each segment label may be found on the following page, **Figure 2-1**. A detailed mapbook of the pipeline route at a scale of 1" = 500' may be found in Appendix K. The mapbook illustrates the pipeline route centerline with a solid orange line and the proposed 150' easement shown with dashed orange lines. Property lines are shown in white. The main pipeline has been stationed beginning at Lake Palestine and ending at the Benbrook Connection in southwest Tarrant County.

Classifications

For each of the routes discussed in this report, the route was classified as to the land type. A length for each land type was determined to assist with cost estimating and to evaluate the construction difficulty for the various routes. A brief definition of each classification used to classify the routes is below.

1. **Rural**: The pipeline route encompasses a majority of undeveloped or farmland and there are only sporadic structures in the area near the route. This classification has been divided into the following sub classifications
    a. Pasture: The easiest construction with very few limitations or restrictions
    b. Croplands: Also easy construction; however, land costs are usually higher due to crop replacement and sensitivity of easement restoration (for example, no rocks left and 2' of top soil be replaced).
    c. Wooded: The contractor will have to add cost to clear trees and work space will be reduced to half the ROW width in this area to reduce construction impact.
2. **Urban**: The pipeline enters a more congested area that has the potential to slow down the pipe laying crew due to limited work space and conflicts with roads, existing utilities, and other structures. This classification has been divided into the following sub classifications
    a. Light Urban: The pipeline route encompasses a majority of area that contains some low- to medium-density subdivisions, but still has a large amount of open space. If there are existing roadways along the route, the roads are rural sections or large open parkways with landscape buffers and/or large medians.
    b. Medium Urban: The pipeline route encompasses a majority of area that has high to medium-density subdivisions throughout, some retail and commercial. There is some open space and/or large parkways with landscape buffers and/or medians.
    c. Heavy Urban: Dense development including residential, retail, and commercial and little to no setback from the roads.

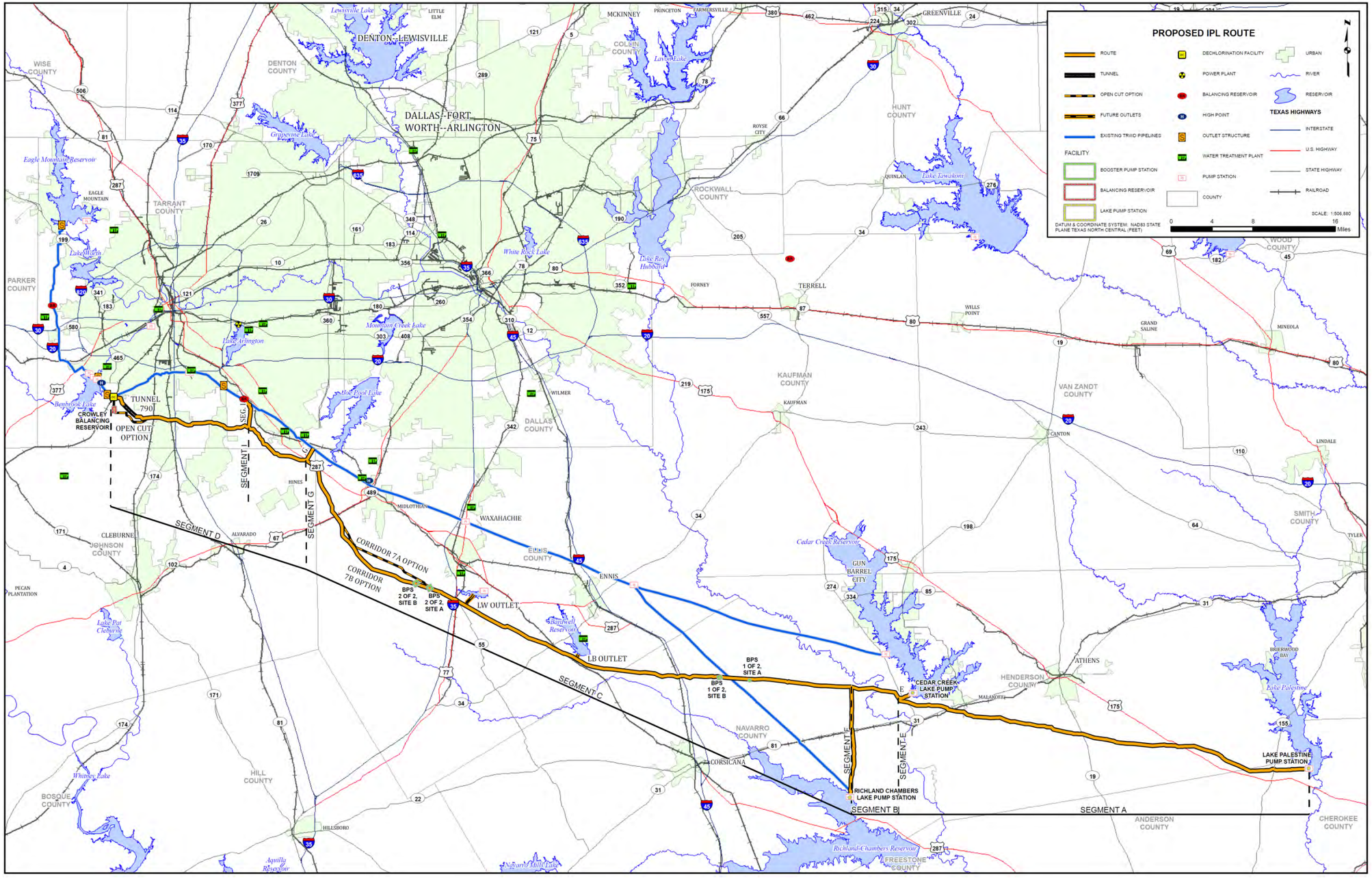

Figure 2-1. Route Overview

3. **Open Cut Crossings**: Crossings that can be open-cut without a tunnel
    a. Minor Road: These are typical county roads and some city streets with lower vehicle counts.
    b. Water Body: Small water bodies such as creeks or ponds that can be dewatered temporarily to facilitate the installation of the pipeline.
4. **Tunnels**:
    a. Crossing Tunnels: This length of the route crosses topographic features or existing facilities such as roadways, railroads, or major utilities that are assumed will need to be tunneled underneath during construction due to the heavy impact that pipeline construction would have on the area. For this stage of the study all existing highways and major roadways were assumed to be tunneled.
    b. Deep Tunnels: In areas of heavy urbanization a deep tunnel, perhaps 40 feet to 100 feet deep, was studied to avoid conflicts. Deep tunnels may also be utilized to reduce power costs by lowering the controlling high point of the proposed pipeline.

Easement Assumptions

Unless specifically noted otherwise, all routes were studied for a 150 foot wide permanent easement. This width allows for the initial construction of one pipeline and future construction of two more pipelines for a total of three pipelines within the easement. It should be noted that certain segments may not need to be planned for three pipelines and a 150 foot width; however, for cost estimating and route selection purposes, a 150 foot wide easement has been assumed. The final easement widths should be determined in the conceptual design phase based on the number of planned pipelines, the design basis of the pipeline and the agreed upon easement restrictions.

2.1 Segment A – Palestine to Cedar Creek

2.1.1 Overview

The beginning point for Segment A is the Lake Palestine Pump Station, which is north of The Meadows subdivision on the southwest side of Lake Palestine. A description of the Lake Palestine Pump Station site is included in Section 3. Segment A is the easternmost segment of the proposed Integrated Pipeline. The route begins at the proposed Lake Palestine Pump Station site and ends at the junction of Segment A and Segment E, southwest of Cedar Creek Reservoir. Refer to **Figure 2-2** for an overall map of Segment A.

This segment of the route has a design capacity of 150 MGD. Sizing of the pipeline is discussed in Chapter 4 of this report. The proposed route is within the boundaries of Henderson County, except for a small portion of the corridor near Lake Palestine which is in Anderson County.

Table 2-2 shows the construction classification for segment A. As seen in the table, Segment A is largely comprised of rural land with 97% of the segment being either pasture or wooded.

Table 2-2. Segment A Route Classification

	Major Classification	Length (LF)	Detailed Classification	Length (LF)
Open Cut	Crossings	2,441	Minor Road	677
			Water Body	1,764
	Rural	213,869	Pasture	117,970
			Cropland	-
			Wooded	95,899
	Urban	2,747	Light Urban	2,747
			Medium Urban	-
			Heavy Urban	-
Tunnel	Crossing Tunnel	1,337	Railroad	142
			River	-
			Major Road	1195
	Deep Tunnel	-	Deep Tunnel	-
Total Length - Segment A				**220,394**

The following facilities and connections are located within Segment A:

- The Lake Palestine Intake Pump Station is located on the most eastern portion of the IPL. The pump station is discussed in detail in Section 3 of this report.
- Segment E Connection is located at the most western point of Segment A, at the junction of Segment A and B. Segment E is addressed as a separate line segment later in this report section.

A proposed outlet to Cedar Creek Reservoir was originally planned for this pipeline segment near the east end of the dam embankment. TRWD prefers to make the line segment from Cedar Creek to the main pipeline, Segment E, bi-directional to serve as a possible outlet into Cedar Creek if necessary.

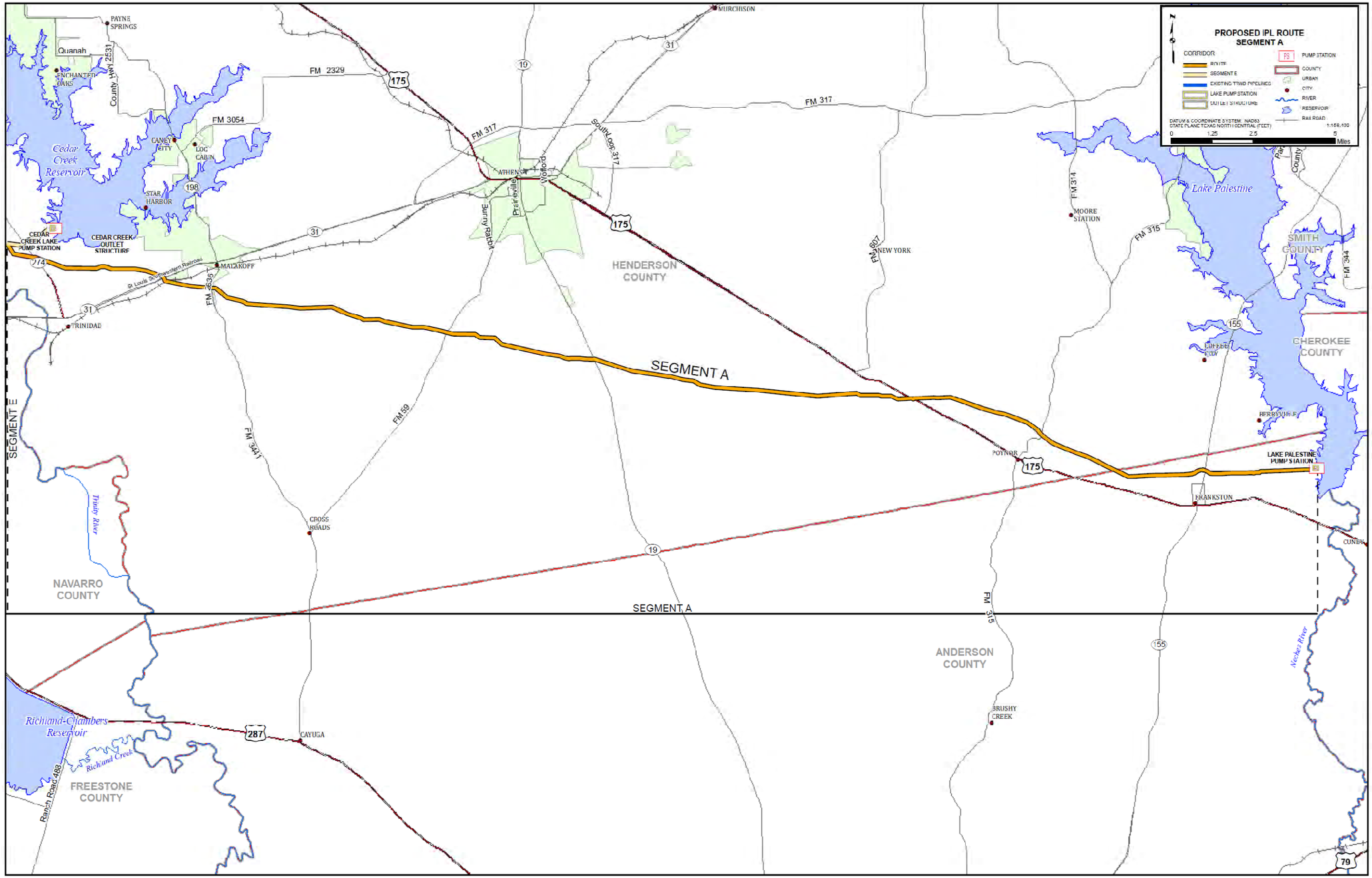

Figure 2-2. Segment A

2.1.2 Route Description and Conflict Analysis

From the proposed Lake Palestine Pump Station, Segment A proceeds to the west-southwest, and then follows along the north side of CR 307. Next, the route moves to the south side of CR 305. The route then passes to the north of Frankston High School. The corridor study placed the proposed pipeline just north of Frankston High School, but it was discovered that the high school has added multiple tennis courts where the route was originally located. Thus the route was moved further north due to the Frankston Riding Center and a car dealership just north of the high school and tennis courts. The following photo (**Figure 2-3**) shows the Frankston High School area facing east. In the photo, the high school, tennis courts, riding center and the car dealership building can be seen. The route will pass in the area to the north of the car dealership.

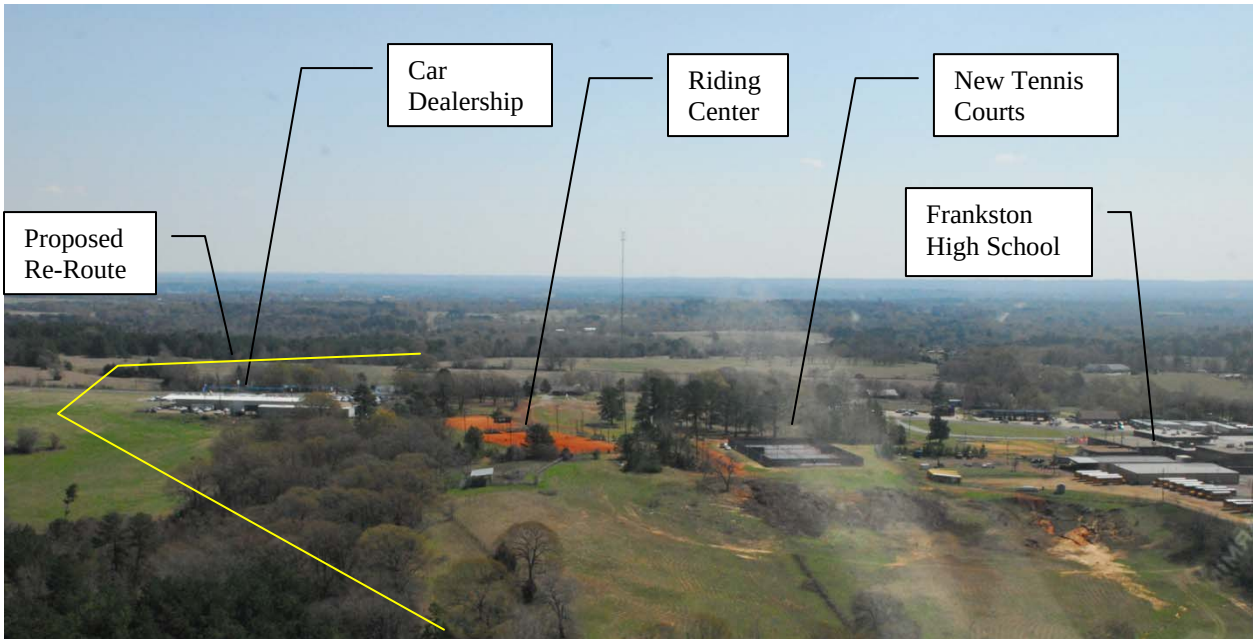

Figure 2-3. Frankston High School Area

Two miles west of Frankston High School, the corridor proceeds northwest. The route passes near LaPoynor High School. A conflict analysis was conducted for the area around the high school. Two options were studied for this area, a northern option and a southern option. (See Appendix J for the complete memorandum and exhibits of the conflict analysis.) The northern option was chosen because it is the shorter, less expensive, and impacts fewer parcels. In addition, the northern option avoided the lakes and water crossings associated with the southern option.

After the route passes north of LaPoynor High School, the route proceeds west-northwest for approximately 23 miles, routing through mainly rural pastures and wooded areas. The route passes roughly five miles south of Athens. After the route crosses the St. Louis Southwestern Railroad and US 31 near Malakoff, the route turns to the northwest and passes south of the Cedar Creek Reservoir. Three options in this area were analyzed. The northern route is the shortest option, but contains six water crossings while the central option has only two creek crossings.

Therefore, the central option was chosen as the best route. (See Appendix J for the complete memorandum.

Segment A ends at the Segment E junction. The Segment A route is approximately 41.7 miles long. **Table 2-3** is a summary of all the areas in which a conflict analysis was performed for Segment A and summarizes the decisions made.

Table 2-3. Conflict Analysis

Conflict Name	ID Number	Decision
CR 301	A1	The northern option is most direct with the least amount of bends.
LaPoynor HS	A2	Routed north due to shortest length and fewest number of parcels impacted.
Hallmark Lake	A3	The southern option requires the shortest length and is less costly.
Cedar Creek	A4	The central option requires the fewest number of water crossings.

Note: Conflicts A1 and A3 were both small conflicts with severed parcels. They were analyzed to minimize parcel severance, but ultimately the most direct routes were chosen; see Appendix J.

2.1.3 Hydraulics

There are several high points located in Segment A that could affect the hydraulics of the system. The highest point reaches a ground elevation of 550 feet MSL while several others reach a ground elevation of 530 feet MSL. Depending upon the location and elevation of the tank/reservoir at BPS 1 of 2, these high points could create an operational issue each time the booster pump station is turned off. The high points will drain toward the BPS storage reservoir with the potential of overflowing the reservoir. In addition, the drained portion of the line will need to be filled slowly each time the system is started to carefully evacuate air. This problem can be solved by lowering the high points or locating the BPS 1 of 2 site to match the reservoir elevation with the pipeline high points. The 550 foot high point can be deep cut for about 1,000 feet near station 810+00 to set the top of pipe at elevation 525 feet MSL. The hydraulics will be discussed further in the facility selection portion of the report and in Section 4.

2.1.4 Crossings

The roads and railroads that will require tunneling on Segment A are listed in **Table 2-4**.

Table 2-4. Segment A Major Crossings

Major Highways	FM Highways	RR/River Crossings
S.H. 155	FM 315	St. Louis Southwestern Railroad
U.S. 175	FM 1615	
S.H. 19	FM 753 (2)	
U.S. 21	FM 59	
S.H. 274	FM 2636 (2)	

Segment A also has four major electrical transmission line crossings that will likely require a crossing permit or agreement.

2.1.5 Environmental

For a detailed analysis of creek crossings see the environmental report in Appendix C. **Table 2-5** is a summary of the environmental areas crossed by Segment A.

Table 2-5. Segment A Environmental Conflicts

	Number	Length, ft	Area, acre
Perennial Creek Crossings	16	3,044	
Intermittent Creek Crossings	68	15,181	
Wetlands			6
Upland Forest			110
Bottomland Hardwoods			33

2.2 Segment B

2.2.1 Overview

Segment B is defined as the pipe segment between the Cedar Creek Pipeline Connection (Segment E) and the Richland-Chambers Pipeline Connection (Section F). Refer to **Figure 2-4** for a map identifying Segment B. Segment B will be sized to accommodate 150 MGD from Lake Palestine and 127 MGD from Cedar Creek Reservoir for a total combined capacity of 277 MGD. The preliminary studies show this pipe segment will be 108-inches in diameter.

Table 2-6 is a summary of the construction classifications for Segment B. As seen in the table, Segment B is largely comprised of rural land with 98% of the segment being either pasture or wooded.

Table 2-6. Segment B Route Classification

	Major Classification	Length (LF)	Detailed Classification	Length (LF)
Open Cut	Crossings	215	Minor Road	131
			Water Body	84
	Rural	25,591	Pasture	18,419
			Cropland	-
			Wooded	7,172
	Urban	-	Light Urban	-
			Medium Urban	-
			Heavy Urban	-
Tunnel	Crossing Tunnel	353	Railroad	-
			River	353
			Major Road	-
	Deep Tunnel	-	Deep Tunnel	-
Total Length - Segment B				**26,159**

There are no proposed facilities situated within the Segment B route, but the following are the connections located within Segment B:

- Segment E Connection from Cedar Creek Lake (at the junction of Segment A and B)
- Segment F Connection from Richland Chambers Lake (at the junction of Segment B and C)

Each of the above connections are addressed as separate segments within this section of the report.

2.2.2 Route Description and Conflict Analysis

Segment B is a short rural segment without any delivery points. The route for Segment B begins at the Segment A-E-B connection and extends north-northwest for half a mile and then proceeds west-northwest through a rural semi-wooded area. Approximately 2.5 miles west-northwest of the connection to Segment E the segment crosses the Trinity River. It is assumed the River Crossing will be tunneled. The next significant element of the pipeline is the connection to Segment F where Segment B ends. The overall length of the Segment B route is 5.0 miles.

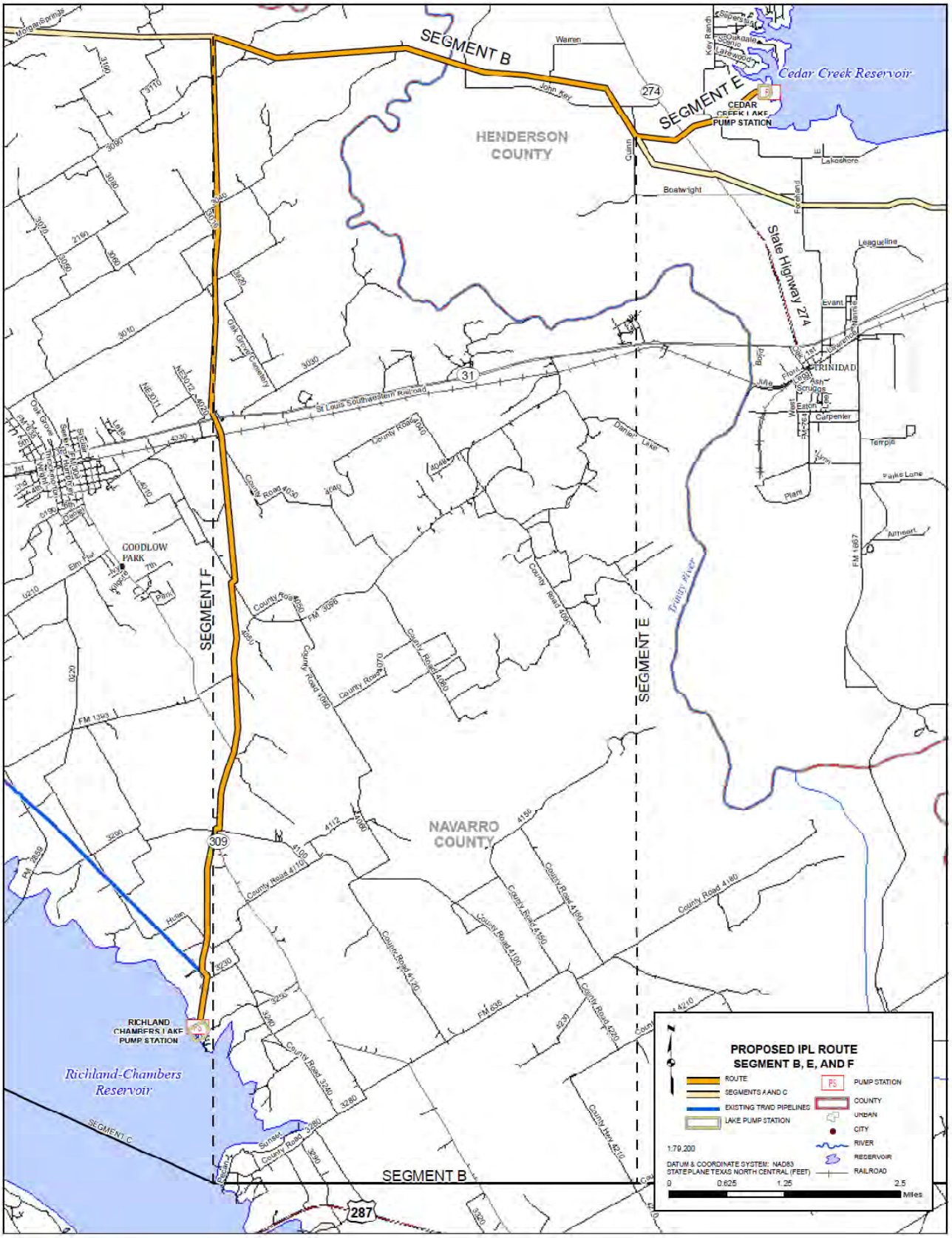

Figure 2-4. Segments B, E, & F

2.2.3 Crossings

Segment B has the one major crossing of the Trinity River, and does not have any major road crossings. Geotechnical borings will be required for the crossing of the Trinity River for tunnel design. The original corridor crossed the Trinity River slightly further south, but the route was moved north to move away from a rural subdivision and out of an old river oxbow to avoid potential poor soil conditions. **Figure 2-5** shows a picture of the Trinity River looking south. It is anticipated that the pipeline will cross the river in the straight run of the river in the foreground. It is anticipated that this river crossing will be constructed with a tunnel from approximately 20-40 feet beyond the tops of banks.

Figure 2-5. Trinity River Crossing (Facing South)

2.2.4 Environmental

For a detailed analysis of creek crossings and other environmental impacts see the environmental report in Appendix C. **Table 2-7** is a summary of the environmental areas crossed by Segment E.

Table 2-7. Segment B Route Environmental Crossings

	Number	Length	Area (ac)
Perennial Creek Crossings	-	-	
Intermittent Creek Crossings	4	766	
Wetlands			14
Upland Forest			3
Bottomland Forest			18

2.3 Segment C

2.3.1 Overview

The beginning point for Segment C is located west of Cedar Creek Reservoir where the pipeline segments B, C, and F all intersect while the end of Segment C is at the connection to Segments D and G. See **Figure 2-6** for a map showing the entire segment. Segment C bears west from the F and B connection and travels south of Bardwell Lake crossing I-45 midway. From Bardwell Lake the route turns northwest passing south of Lake Waxahachie, crossing I-35E and arriving at a point to the south of hill country near Midlothian. The hill country south of Midlothian acts as a turning point for the route as it heads more northerly towards the ending point at the D and G connection near the intersection of S.H. 360 and 287. Segment C is the longest IPL segment accounting for 42% of the entire route.

The final route preferred for Segment C changed significantly from the corridor (Corridor 5) selected in the previous corridor study. During the detailed analysis of the corridor, several challenges presented themselves including a wildlife refuge, several urban areas near Midlothian and significant impacts to USACE property around Lake Bardwell. For this reason, other corridors (Corridor 6 & 7) were proposed, studied and compared against Corridor 5. An evaluation of the corridors led the owners to choose the southern Corridor 7 as it missed USACE property and is a more rural route. In addition, a specific corridor, identified as Corridor 7b, that routed south of Midlothian was found to be more advantageous from an energy savings standpoint as it missed several highpoints. A detailed analysis comparing the above corridors may be found in Appendix J as C11. Corridor 7b was preferred by the owners and is described hereafter. **Table 2-8** summarizes the breakdown of this segment:

Table 2-8. Segment C Classification

	Major Classification	Length (LF)	Detailed Classification	Length (LF)
Open Cut	Crossings	1,813	Minor Road	1,115
			Water	698
	Rural	310,388	Pasture	166,885
			Cropland	85,975
			Wooded	57,528
	Urban	14,249	Light Urban	14,249
			Medium Urban	0
			Heavy Urban	0
Tunnel	Crossing Tunnel	2,938	Railroad	767
			River	0
			Major Road	2171
	Deep Tunnel	0		
Total Length - Segment C				**329,388**

Both booster pump stations on the IPL are located within segment C. The first or upstream BPS is situated near the RC pipeline crossing. The second or downstream BPS is west of I-35E near FM 66. Both of the BPS sites are presented with two options in section 3.

There are five proposed connections within Segment C.

1. The Segment F Connection is located at the beginning of Segment C.
2. **RC Cross-Connection**: A connection to the existing RC pipeline will be made where the RC pipeline and the IPL cross. This intersection is just east of FM 1603 near Chatfield. The connection adds reliability as it allows several bypassing and pumping options. The connection also allows deferment of Segment F construction.
3. **Bardwell Reservoir Outlet**: Approximately 15,000 feet east of the State Highway 34 crossing, a connection will be made for the Bardwell Lake outlet. The outlet is planned as a future connection and is not anticipated to be built with the IPL. The future connection will be approximately 2,570 feet long. It will approach the lake from the south, west of Bardwell Dam. Approximately 1,400 feet of the connection will cross USACE property thus requiring an easement from the USACE. The City of Waxahachie currently uses Lake Bardwell as a water source and can pump Bardwell water to Lake Waxahachie or to their WTP. The city has plans to expand their WTP from 15 MGD to 27 MGD. This connection will help accommodate the city's future demands.

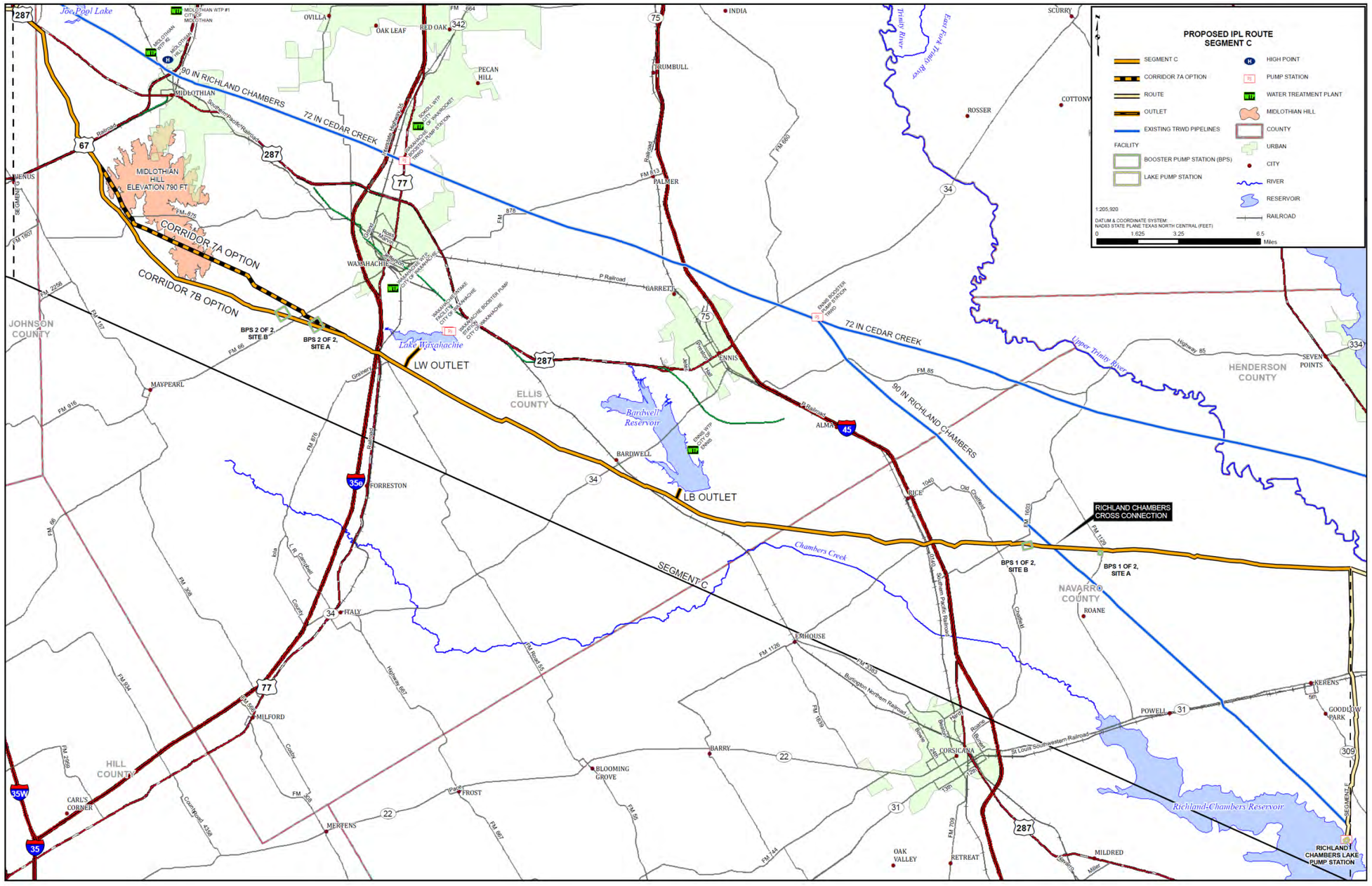

Figure 2-6. Segment C

4. **Lake Waxahachie Outlet**: A little over a mile east of I-35E will be a future connection to Lake Waxahachie. The outlet will be an approximate 7,194 feet in length approaching the lake from the south. Similar to the Bardwell connection, this connection will contribute to the supply for the city of Waxahachie. The connection will not require USACE permitting, but will require easements through private lake front property. The lake is owned by the Ellis County Water Control and Improvement District No. 1.
5. The Segment G connection defines the end of Segment C. Segment G delivers 150 MGD to Dallas and is addressed separately as a segment in this section of the report.

2.3.2 Route Description and Conflicts

From the beginning point at the F and B connection, Segment C travels approximately 10 miles west to the intersection of FM 1129 and FM 636. The majority of this route crosses open rural land, with several minor road crossings and a crossing of a residential area, the Colina Vista subdivision on Colina Vista Road east of FM 1129. The Colina Vista Subdivision tracts are approximately 10 acres each, and the route does not require the removal of any houses. The route crosses the existing 90-inch RC pipeline where a cross-connection is proposed. There are two alternate booster pump station sites located in this area, Site A located near the intersection of FM 1129 and FM 636 and Site B just west of the RC cross-connection new FM 1603. These two sites are discussed further in Section 3.

Two additional residential areas are crossed before the route reaches I-45. The first is at the crossing of FM 1603 approximately half a mile to the west of BPS 1 of 2 B. This residential area is composed of approximately 10 acre tracts, with homes on these tracts generally abutting the roadway. The route crosses perpendicular to FM 1603 through an undeveloped tract, then continues west across the backs of the parcels.

The second residential area is the Double R subdivision outside of Rice situated just east of I-45. This subdivision consists of approximately 5 acre tracts. At the time of this route study, little housing construction has occurred in this area. This subdivision was identified as a conflict area, and a route analysis comparing three routes was performed. This route analysis is included in Appendix J as C2a-Rice. None of the conflict options require the demolition of houses but they all sever some of the properties in the subdivision. The southern option was chosen for the route due to reduced severed lengths, cost benefits, and environmental advantages.

From the west side of I-45, the route continues traveling west through mostly crop and pasture land to the south end of Bardwell Reservoir. The main pipeline does not route through USACE property which was one of the significant advantages of Corridor 7b over other corridor options which had environmental and USACE conflicts on the north side of Bardwell Lake.

From the future Bardwell outlet, the route turns northwest and crosses the BNSF Railroad. The route continues for approximately 12 miles through rural crop and pasture land to the future Lake Waxahachie outlet. Going south of Lake Waxahachie helps avoid environmental and urban conflicts that are on the north side of the lake.

On the west side of the lake, the pipeline crosses the UP Railroad, US Highway 77, and I-35E which are all adjacent to each other. One mile further west is where Corridor 7a and 7b diverge. The recommended route follows Corridor 7b which avoids high points in Midlothian reducing pumping costs and eliminating the need for a Midlothian deep tunnel. Near the point where 7a and 7b converge back together at US Highway 67 the original 7b route crossed a pond. A

conflict analysis was done for this area comparing two routes. The conflict is included in appendix J as C8a-ToysRUs. The eastern option was chosen as it was less expensive and avoided the pond.

After crossing US Highway 67, the route bears northwest approximately 6.5 miles through rural property before tying into Segments G and D. Directly to the southeast of the G connection, Segment C parallels US Highway 287. State Highway 360 currently ties into US Highway 287 along this paralleling portion. In the future, State Highway 360 will likely be extended to the south, crossing both US Highway 287 and the IPL route. This should be investigated further in the conceptual design to determine if the pipe under the future SH 360 should be encased or deepened.

Table 2.9 shows the conflict analysis areas that were studied for Corridor 7b on Segment C. The complete conflict analysis for Segment C can be reviewed in Appendix J.

Table 2-9. Segment C Conflicts

Conflict Name	ID Number	Decision
Rice	C2a	South option was chosen for severance, environmental and cost benefits.
Toys R Us	C8a	Eastern option was chosen as it missed the pond conflict and presented cost savings.
New Southern Option	C11	The corridor 7b was chosen due to reduced urban impact and reduced pumping costs by routing around Midlothian Hill.

2.3.3 Hydraulics

Segment C is planned to carry 150 MGD from Lake Palestine, 127 MGD from Cedar Creek Reservoir, and an additional 70 MGD from Richland-Chambers Reservoir for a total of 347 MGD. This segment will be 108 inches in diameter. Segment D of the IPL will be downsized to 84 inches in diameter as Dallas water is delivered through Segment G.

One of the primary reasons the 7b route was preferred over others was for reduced pumping costs due to lower static heads. Other routes (1a/5, 1b/5, 1b/6, 7a) were considered which passed through higher elevations near Midlothian. See Conflict C11 in Appendix J. The alternate options either require increased pumping costs or deep tunneling options. A life cycle cost analysis performed on the routes showed that there are life cycle cost savings in reducing the high point in the pipeline to elevation 790 feet MSL. The Corridor 7b re-route reduced the high point from elevation 850 to elevation 790 and was found to be more cost effective than tunneling through these high points with other route options.

2.3.4 Crossings

Tunnel crossings in Segment C include 2 interstate highways, 1 state highway, 2 US highways, 14 FM roads, and 4 railroads. There is also a rail track that is not a mainline railroad near the Toys R Us conflict. **Table 2-10** summarizes which major roads will be crossed utilizing tunneling.

Table 2-10. Tunneled Crossings

Major Highways	FM Highways	Railroad / River Crossings
I 35 E	1129	Southern Pacific Railroad
I 45	1446	BNSF Railroad (near SH 34)
SH 34	1493	UP Railroad
US Highway 67	1603	BNSF Railroad (near US 67)
US Highway 77	636	Branch Line at Business Park
	66	
	875	
	876	
	977	
	984 (Crosses four times)	
	985	

Segment C will also include approximately 24 oil and gas crossings and 8 electrical transmission line crossings. These crossings are anticipated to be open cut.

2.3.5 Environmental

Table 2-11 summarizes environmental conflicts along segment C.

Table 2-11. Segment C Environmental Conflicts

	Number	Length, ft	Area, acre
Perennial Creek Crossings	5	970	
Intermittent Creek Crossings	113	21,402	
Wetlands			6
Upland Forest			109
Bottomland Forest			28

2.4 Segment D

2.4.1 Overview

Segment D continues from C at the connection point of G and ends at the Benbrook Pipeline tie-in located less than one mile east of the existing Benbrook outlet. The intersection of segments C, D and G is near the intersection of US Highway 287 and the US Highway 287 Business route which is southeast of Mansfield. See **Figure 2-7** for a depiction of the entire segment.

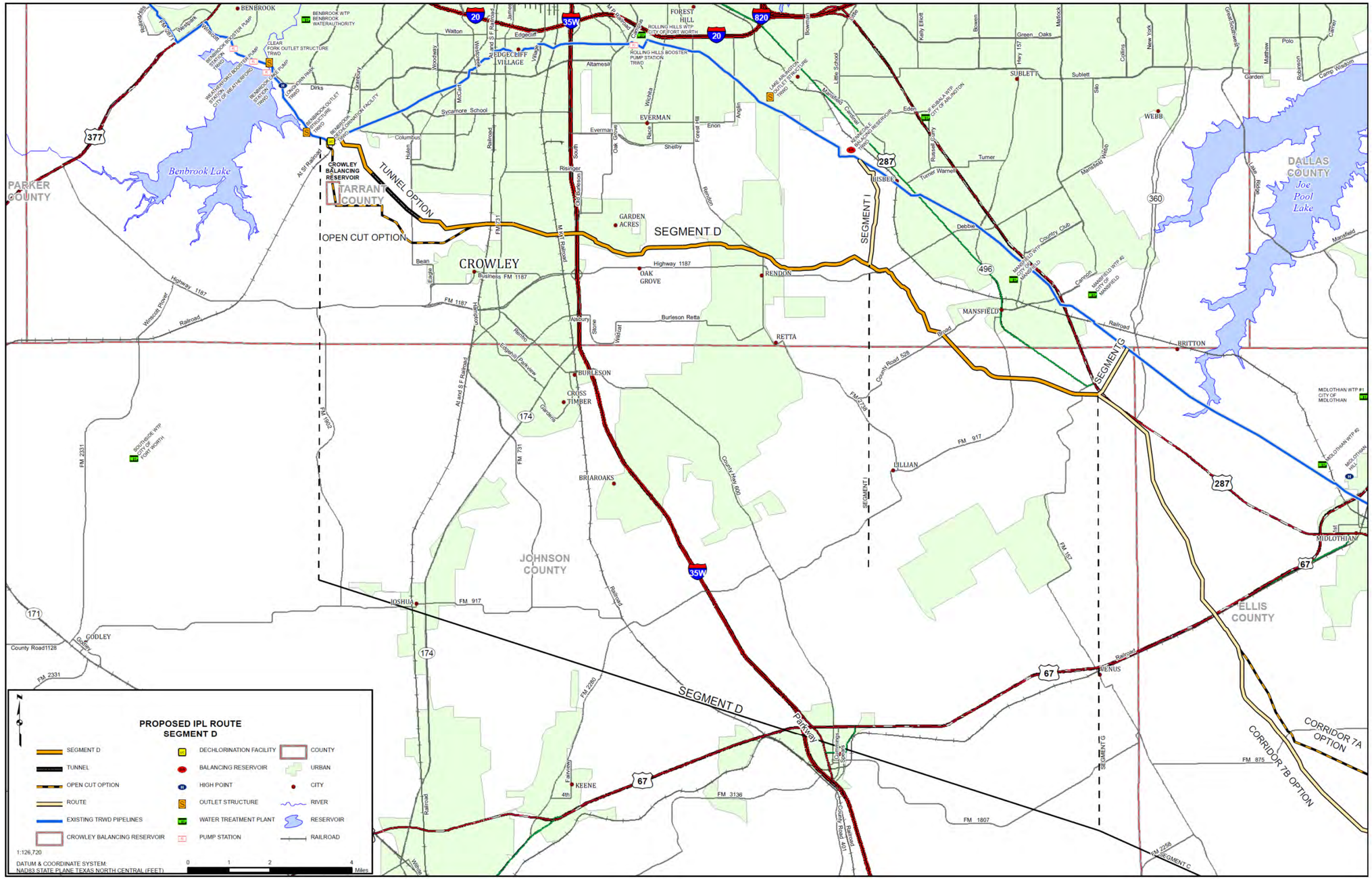

Figure 2-7. Segment D

The total length of segment D is 21.6 miles accounting for 15% of the entire mainline of the IPL route. Over 80% of the segment is composed of rural land. Currently the only deep tunnel on the IPL route is located near the end of segment D near Crowley. **Table 2-12** summarizes the breakdown of this segment:

Table 2-12. Segment D Classification

	Major Classification	Length (LF)	Detailed Classification	Length (LF)
Open Cut	Crossings	1,137	Minor Road	924
			Water	213
	Rural	93,032	Pasture	56,708
			Cropland	14,139
			Wooded	22,185
	Urban	10,412	Light Urban	10,197
			Medium Urban	215
			Heavy Urban	0
Tunnel	Crossing Tunnel	1,070	Railroad	189
			River	0
			Major Road	881
	Deep Tunnel	8,480	Deep Tunnel	8,480
Total Length - Segment D				**114,131**

With a two booster pump operation and a deep tunnel at Crowley, there are no facility sites situated along this segment. However, if the tunnel option through Crowley is found unfeasible, an open cut option with the Crowley Balancing Reservoir may be considered. The Crowley Balancing Reservoir is discussed as an option in segment 3 of this report. There are three segment D connections:

- The Segment G Connection, which is discussed separately, is currently planned to divert 150 MGD to a Dallas delivery point.
- The Segment I (KBR) Connection which is discussed separately connects to D near the US Highway 1187 crossing. Segment I is 84 inch in diameter to carry 197 MGD to the Kennedale Balancing Reservoir.
- Currently, the IPL terminates at the connection to TRWD's existing 90" Benbrook Pipeline. The Benbrook Pipeline was built in the mid 1990's and is prestressed concrete cylinder pipe (PCCP) through the open cut sections and steel pipe through the tunnel segment. The Benbrook Tunnel begins on the west side of Granbury Road, on USACE property. Connecting west of Granbury Road near the existing TRWD dechlorination facility in the open cut section is simplest from a construction standpoint. However, such a connection requires a USACE easement which entails an environmental analysis and mitigation. To reduce impact to USACE property, the connection is currently planned to be on the east side of Old Granbury Road as shown in **Figure 2-8**. This is in the tunneled portion which is approximately 30 feet deep. Thus, the connection will be in a deep trench and the casing will need to be removed from around the existing pipe. Connecting

to the east is less desirable for construction, but more desirable from a schedule and property standpoint as permitting and mitigation is avoided.

2.4.2 Route Description and Conflicts

From its beginning at the Segment G connection, the Segment D pipeline routes northwest approximately seven miles to the point where Segment I connects to the main pipeline. Just southeast of the Segment I intersection is conflict area D1-Mansfield. See Appendix J for conflict analysis D1-Mansfield and D1a-Mansfield. Upon evaluation of the conflict area, the northeastern route option was chosen. The northeastern option is more rural than the other options bypassing several well pads to the east of an electrical transmission line and crossing FM 1187 before the Segment I connection. The northeastern option was chosen due to reduced environmental impacts, cost advantages and the fact that it missed a new mining operation and several structures. All other options required the demolition of several small homes.

After the Segment I connection, Segment D turns from bearing northwesterly to bearing westerly. Approximately 3 miles west of the Segment I connection, the route passes through another conflict area. See Appendix J for conflict analysis D2-Rendon. Four routes were considered for routing through the urban Rendon congestion. All routes considered require the demolition of houses. The selected route is the northern most which requires the demolition of a single house while the other routes required the demolition of 3, 4, and 5 houses. The house on the chosen route lays just to the east of the intersection of Rendon Road and Valley Ridge road.

The Segment D route continues west to conflict D3-I35; see Appendix J for the conflict analysis. The northern option which routes north of Crowley Middle School at FM 731 was chosen for the route by TRWD on February 10, 2010. Although this was not the least expensive route, it was most favorable due to avoiding urban conflicts and conflicts with the middle school.

West of I-35W, two routes were studied to connect to the Benbrook Pipeline. The first route is an open cut option that winds through several subdivisions to a high point west of Crowley and a site of a potential terminal storage reservoir. The reservoir would have several operational benefits, but adds power cost at low flow rates. From the reservoir, the pipeline bears in a northerly direction and tunnels under a railroad and Old Granbury Road to connect to the Benbrook Pipeline on USACE property.

A second route, called the 790 Tunnel Option, takes a more direct route to the proposed Benbrook connection point and tunnels at elevation 790’ MSL under the high ridge passing through Crowley. Although the tunnel option is more expensive in capital costs, life cycle costs show a breakeven point after 100 years. In addition, the tunnel route will have less impact on the environment, less impact on the community and should require less maintenance. The 790 Tunnel Option was chosen by TRWD as the preferred route. **Figure 2-9** shows the two alignments studied through the Crowley area and the portion of the pipeline to be installed in a tunnel.

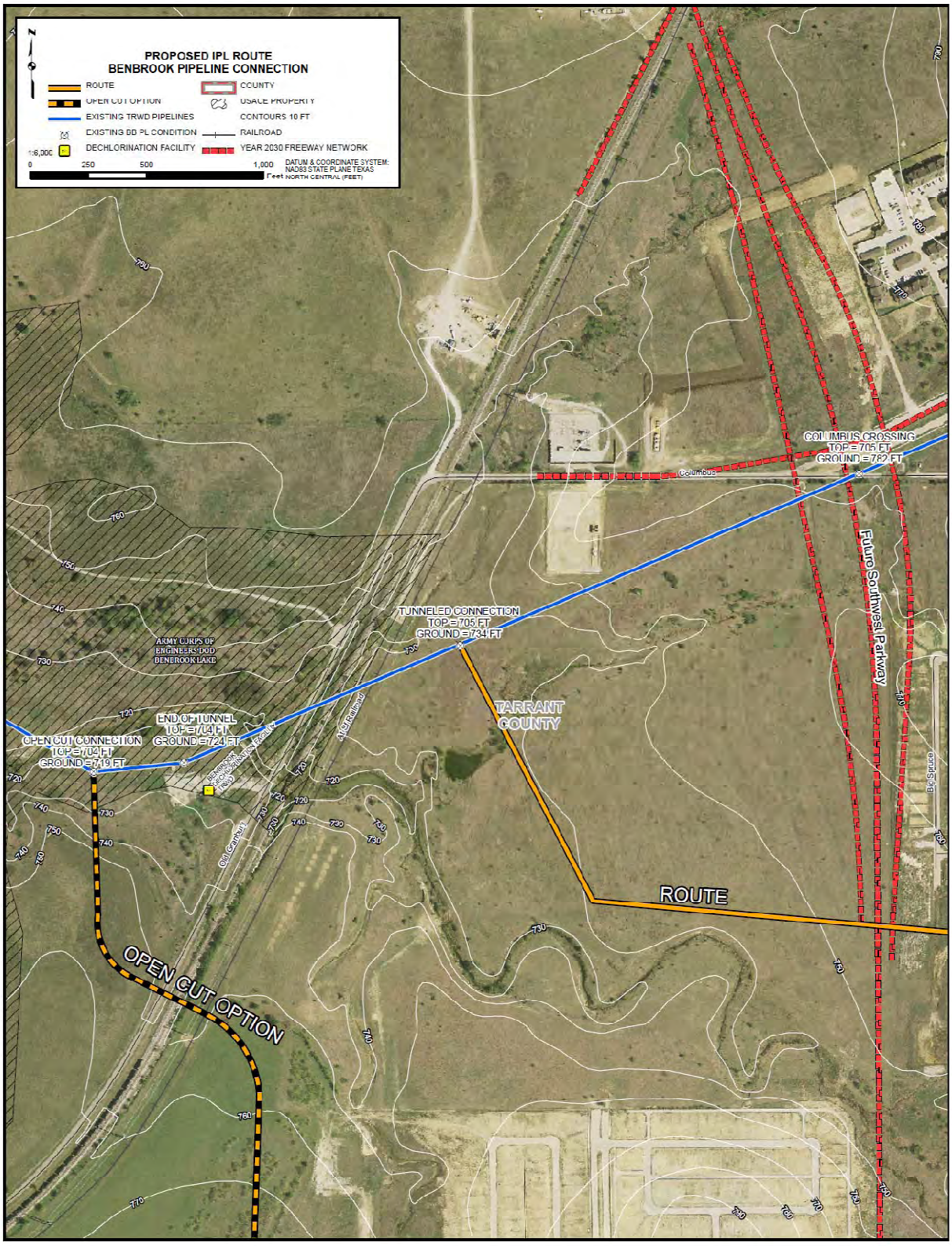

Figure 2-8. Benbrook Connection

The chosen 790 Tunnel Option extends from the northern D3-I35 option to a point southeast of Crowley High School. At this point the tunnel passes under the High School property to an open lot lying between a subdivision and a gas facility. The length of the tunnel is 8,480 feet and is approximately 50 feet deep.

From the end of the tunnel the route bears northerly along a subdivision before turning west for the proposed crossing of the future Southwest Parkway. Soon after the proposed Southwest Parkway crossing, the route ties into the existing Benbrook waterline on the east side of Old Granbury road. This portion of the Benbrook line was tunneled which will require a deep connection point. However, by connecting to the east of Old Granbury road instead of the west, USACE property can be avoided.

Table 2-13 shows the conflict analysis areas that were studied for Segment D. The complete conflict analysis' can be reviewed in Appendix J.

Table 2-13. Segment D Conflicts

Conflict Name	ID Number	Decision
Mansfield	D1	Moved to the east of the power-line easement to miss two houses and the new mining operations.
Rendon	D2	Re-routed north to miss two houses.
I35	D3	North route to avoid school and urban conflicts.

2.4.3 Hydraulics

As described above, pumping costs are reduced by utilizing a deep tunnel through the ridge near Crowley. This lowers the high point of the line by approximately 50 feet. An alternative to this is an open cut route to the south of Crowley High school and a balancing reservoir. While the open cut alternative would present lower construction costs, the tunnel was chosen to reduce long term pumping and maintenance cost.

2.4.4 Crossings

Tunnel crossings in Segment D include an interstate highway, four FM roads, and two railroads as listed in **Table 2-14**.

Table 2-14. Tunneled Crossings

Major Highways	FM Highways	Railroad / River Crossings
I-35W	157	MKT Railroad
	917	AT & SF Railroad
	1187	
	731	

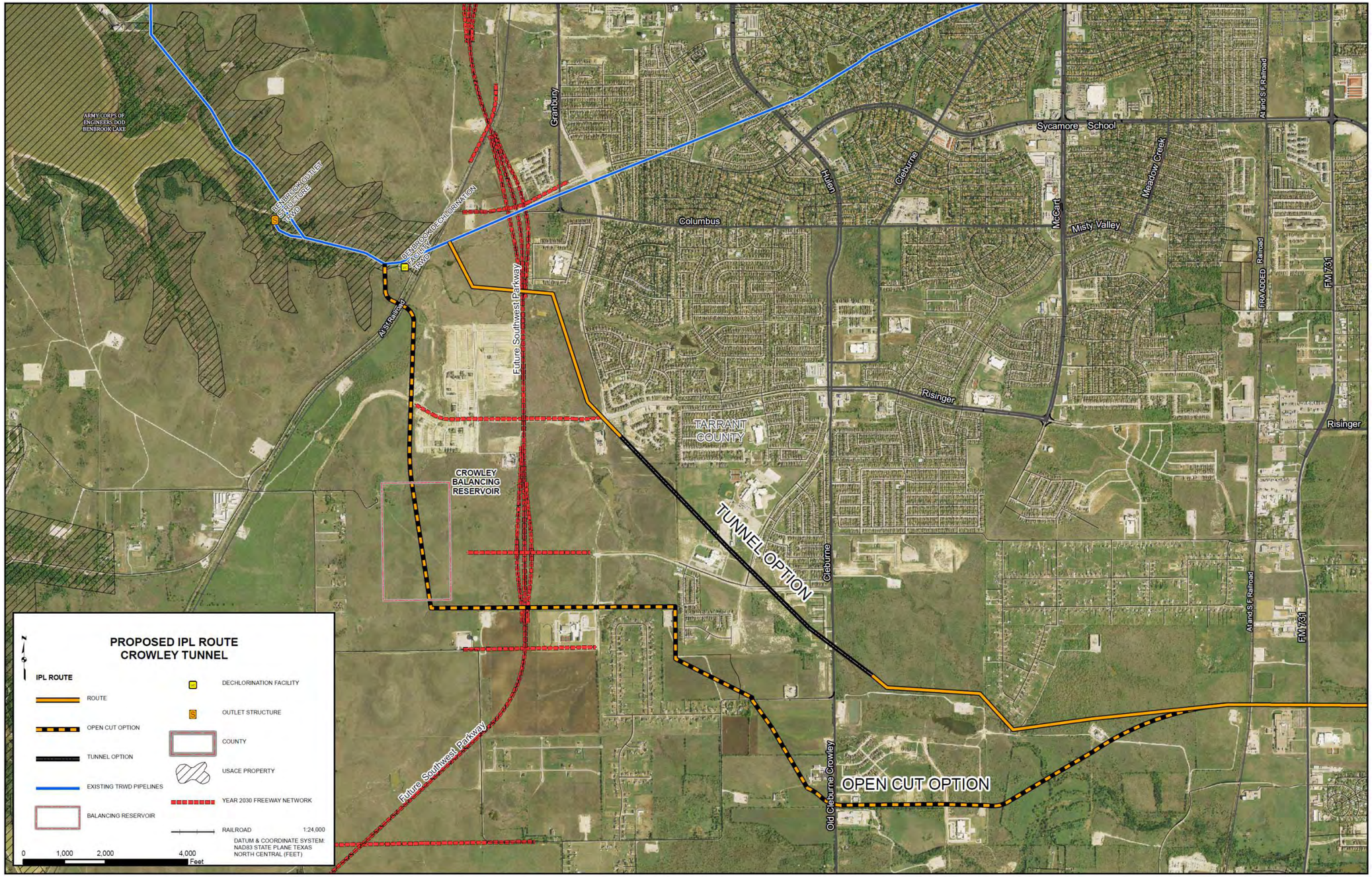

Figure 2-9. Crowley Tunnel Options and Alternate Open Cut Option

Segment D will also include approximately 34 oil and gas crossings and 17 electrical transmission line crossings. These crossings will be open cut.

2.4.5 Environmental

Table 2-15 summarizes environmental conflicts along segment D.

Table 2-15. Segment D Environmental Conflicts

	Number	Length, ft	Area, acre
Perennial Creek Crossings	3	536	
Intermittent Creek Crossings	24	5,272	
Wetlands			2
Upland Forest			6
Bottomland Forest			65

2.5 Segment E – Cedar Creek to Integrated Pipeline

2.5.1 Overview

Segment E begins at the proposed Cedar Creek Reservoir Pump Station at the southwest corner of Cedar Creek Reservoir. Segment E proceeds southwest from the proposed pump station and connects to the Integrated Pipeline at the beginning of Segment B. Segment E has a 72-inch diameter and it has a design capacity of 127 MGD. Refer to **Figure 2-4** for a map featuring Segment E.

Table 2-16 is a summary of the Segment E route construction classification. As seen in the table, Segment E is mainly comprised of rural land with 98% of the route being either pasture or wooded areas. Nearly ninety percent of the segment passes through rural prairies, and the remaining ten percent passes through densely wooded areas.

Table 2-16. Segment E Route Classification

	Major Classification	Length (LF)	Detailed Classification	Length (LF)
Open Cut	Crossings	29	Minor Road	29
			Water Body	-
	Rural	8,370	Pasture	-
			Cropland	7,557
			Wooded	813
	Urban	-	Light Urban	-
			Medium Urban	-
			Heavy Urban	-
Tunnel	Crossing Tunnel	118	Railroad	-
			River	-
			Major Road	118
	Deep Tunnel	-	Hydraulic Advantage	-
Total Length – Segment E				**8,517**

The only facility located within the Segment E route is the Cedar Creek Reservoir Intake Pump Station at the beginning of the route. A description of the proposed Cedar Creek Reservoir Pump Station is included in Section 3.

2.5.2 Route Description and Conflict Analysis

Segment E has a length of 8,517 feet, and a few bends. One bend is to miss a cemetery and the other to avoid businesses and residences along State Highway 274. The pipeline will pass through the Cedar Creek Reservoir dam embankment which will require a special design with review and approval by TCEQ. This design could require an aerial crossing but a more typical design would be a concrete encased section of pipe through the embankment with select backfill. Tunneling will also be required for the crossing of State Highway 274.

2.5.3 Environmental

For a detailed analysis of creek crossings see the environmental report in Appendix C. **Table 2-17** is a summary of the environmental areas crossed by Segment E.

Table 2-17. Segment E Environmental Conflicts

	Number	Length, ft	Area, acre
Perennial Creek Crossings	-	-	
Intermittent Creek Crossings	1	196	
Wetlands			1
Upland Forest			1
Bottomland Forest			0

2.6 Segment F

2.6.1 Overview

Segment F begins at the existing Richland-Chambers Reservoir Pump Station on the north shore of Richland-Chambers Reservoir as shown in **Figure 2-4**. The end point of Segment F is approximately 11 miles north at the end of Segment B and the beginning of Segment C. Segment F generally runs north from the Richland-Chambers Reservoir Pump Station to the east side of Kerens and continues north to the connection point with Segments B and C. **Table 2-18** summarizes the breakdown of this segment:

Table 2-18. Segment F Route Classification

	Major Classification	Length (LF)	Detailed Classification	Length (LF)
Open Cut	Crossings	552	Minor Road	400
			Water	152
	Rural	56,727	Pasture	36,358
			Cropland	5,803
			Wooded	14,566
	Urban	0	Light Urban	0
			Medium Urban	0
			Heavy Urban	0
Tunnel	Crossing Tunnel	489	Railroad	120
			River	0
			Major Road	369
	Deep Tunnel	0	Deep Tunnel	0
Total Length – Segment F				**57,768**

Segment F is proposed to carry 70 MGD from Richland Chambers Reservoir. This segment will be 66-inches in diameter.

2.6.2 Route Description and Conflicts

The route parallels the existing 90-inch Richland Chambers pipeline for the first 3,600 feet then travels north toward Kerens. The route travels across rural areas to State Highway 309, parallels the west right-of-way of SH 309 for 700 feet, crosses Highway 309, and then parallels the east right-of-way line for 4,400 feet. This jog across the road helps decrease wooded area crossing on the west side of SH 309. The route continues north across mostly open rural land to the crossing of the St. Louis Southwestern Railroad and State Highway 31 approximately 1.6 miles east of Kerens. North of the highway, the route continues to the connection with Segments B and C through mostly open pasture land.

No conflict analysis areas were required during the Segment F route selection.

2.6.3 Crossings

Tunnel crossings in Segment F include 2 state highways, 1 FM road, and 1 railroad. **Table 2-19** summarizes which major roads will be crossed utilizing tunneling.

Table 2-19. Tunneled Crossings

Major Highways	FM Highways	Railroad / River Crossings
SH 309	3096	St. Louis Southwestern
SH 31		

Segment F will also include approximately 3 oil and gas crossings and 3electrical transmission line crossings. These crossings are anticipated to be open cut.

2.6.4 Environmental

Table 2-20 summarizes environmental conflicts along Segment F.

Table 2-20. Environmental Conflicts

	Number	Length, ft	Area, acre
Perennial Creek Crossings	2	409	
Intermittent Creek Crossings	10	2,150	
Wetlands			3
Upland Forest			15
Bottomland Forest			5

2.7 Segment G

2.7.1 Segment G Overview

Segment G begins near the intersection of US Highway 287 and State Highway 360 where pipeline Segments C and D intersect as shown in **Figure 2-10**. The end point of Segment G is at the connection to the existing Richland-Chambers pipeline, approximately 1.4 miles to the north. Segment G generally runs north from Segments C and D to the connection point across open rural land. **Table 2-21** summarizes the breakdown of this segment:

Table 2-21. Segment G Route Classification

	Major Classification	Length (LF)	Detailed Classification	Length (LF)
Open Cut	Crossings	27	Minor Road	27
			Water	0
	Rural	6,759	Pasture	172
			Cropland	5,989
			Wooded	598
	Urban	0	Light Urban	0
			Medium Urban	0
			Heavy Urban	0
Tunnel	Crossing Tunnel	334	Railroad	0
			River	0
			Major Road	334
	Deep Tunnel	0	Deep Tunnel	0
Total Length – Segment G				**7,120**

2.7.2 Route Description and Conflicts

Three routes were studied for segment G all of which traveled roughly 1.5 miles northerly to the existing RC-pipeline. See Appendix J for the conflict analysis comparing the three options. The western option, which was chosen due to shorter length and reduced cost, travels north from the beginning point at Segments C and D across an open field to the connection point with the existing Richland-Chambers pipeline.

2.7.3 Hydraulics

Segment G is proposed to carry 347 MGD from the IPL to the Richland-Chambers pipeline. This segment will be 108-inches in diameter. This will allow Dallas to deliver 150 MGD to Joe Pool Lake or to Bachman WTP through Segment H. With Segment I, TRWD does not need the ability to deliver 197 MGD through Segment G; however, the added flexibility and redundancy may justify keeping Segment G in the IPL

2.7.4 Crossings

Tunnel crossings in Segment G include 1 US highway. **Table 2-22** summarizes which major roads will be crossed utilizing tunneling.

Table 2-22. Tunneled Crossing

Major Highways	FM Highways	Railroad / River Crossings
US Highway 287	----	----

Segment G will also include approximately 1 oil and gas crossings with no major electrical transmission line crossings. The crossing is anticipated to be open cut.

2.7.5 Environmental

Table 2-23 summarizes environmental conflicts along Segment G.

Table 2-23. Environmental Conflicts

	Number	Length, ft	Area, acre
Perennial Creek Crossings	-		
Intermittent Creek Crossings	2	339	
Wetlands			-
Upland Forest			2
Bottomland Forest			1

2.8 Segment I

2.8.1 Overview

Segment I, also called the KBR connection, branches from Segment D near the crossing of FM 1187. After traveling north approximately three miles through rural pasture and light urban conflicts, the route will join TRWD's existing pipeline. From this point, the Kennedale Balancing Reservoir is located 1,000 feet to the northwest. It has not been determined if the pipeline can connect to the existing pipelines at this location, or if the pipeline will need to be extended to the KBR, paralleling the existing TRWD pipelines. See **Figure 2-10** for the route location. **Table 2-24** summarizes the breakdown of this segment.

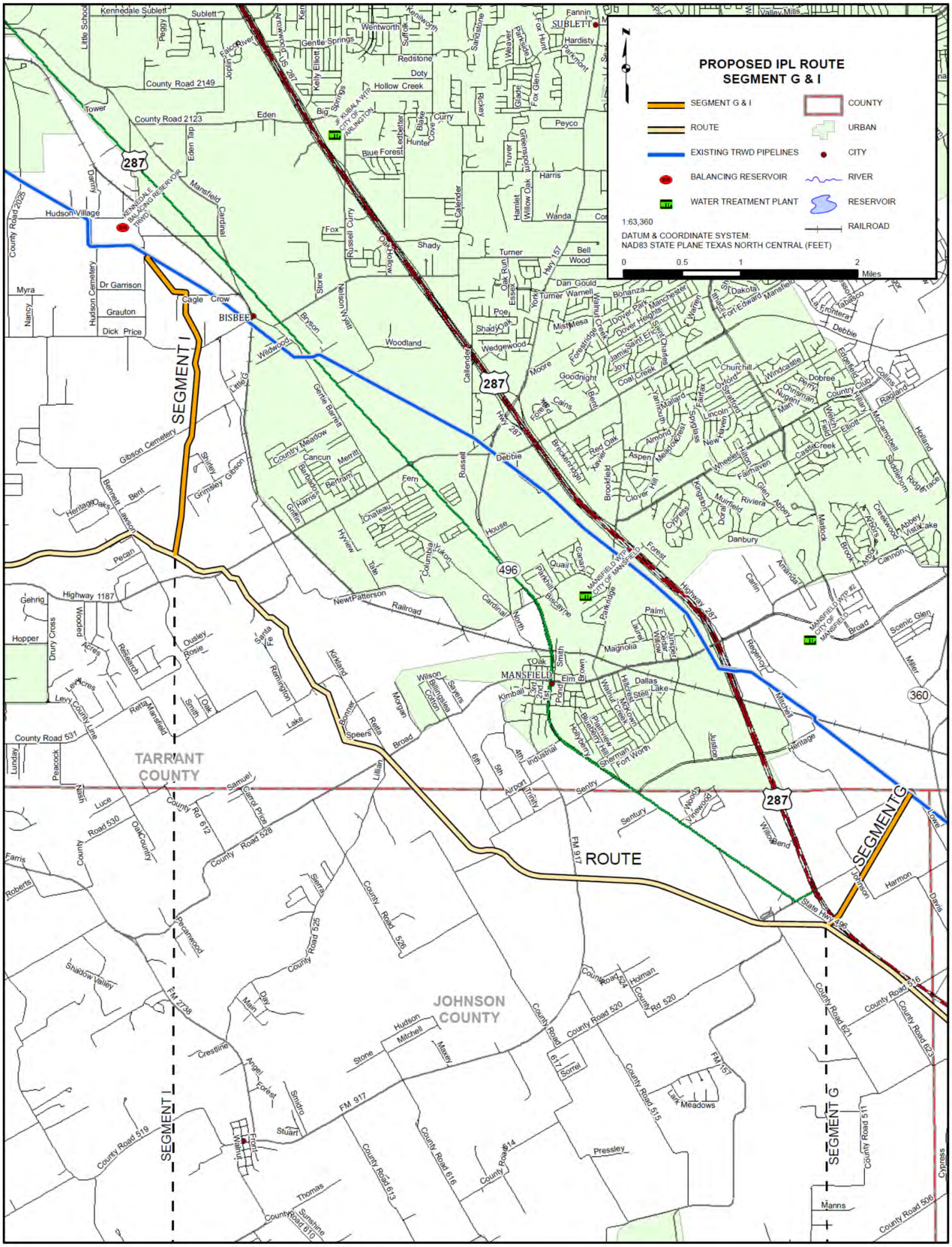

Figure 2-10. **Segments G & I**

Table 2-24. Segment I Classification

	Major Classification	Length (LF)	Detailed Classification	Length (LF)
Open Cut	Crossings	178	Minor Road	178
			Water	0
	Rural	13,105	Pasture	8,922
			Cropland	0
			Wooded	4,183
	Urban	1,482	Light Urban	1,482
			Medium Urban	0
			Heavy Urban	0
Tunnel	Crossing Tunnel	0	Railroad	0
			River	0
			Major Road	0
	Deep Tunnel	0	Hydraulic Advantage	0
Total Length – Segment I				**14,765**

2.8.2 Route Description and Conflicts

A field visit on March 25, 2010 confirmed that several possible routes paralleling a gas line are not feasible. Thus, a portion of the route was shifted approximately 1,000 feet to the east of the originally conceived route. The route now bears north until crossing Dick Price Road. At Dick Price the route turns to the northwest gradually drawing closer to the existing waterline.

2.8.3 Hydraulics

The purpose of this segment is to provide a cross connection to the existing East Texas System. The cross-connection provides the ability to increase the delivery rate to KBR without having to parallel the existing 90-inch and 72-inch pipelines through the urban Mansfield area. In turn, this will increase reliability and will give TRWD multiple options in managing water within their existing network.

2.8.4 Crossings

There are no major road or railroad crossings within segment I. The route crosses several minor roads which are anticipated to be open cut. From south to north the roads are:

- Gibson Cemetery Road
- Dick Price Road
- Cagle Crow Road

The pipeline also crosses several driveways, approximately four oil and gas lines and one electrical transmission line.

2.8.5 Environmental

Table 2-25 summarizes environmental conflict along segment I.

Table 2-25. Segment F Environmental Conflicts

	Number	Length, ft	Area, acre
Perennial Creek Crossings	1	175	
Intermittent Creek Crossings	1	28	
Wetlands			1
Upland Forest			8
Bottomland Forest			1

2.9 Next Steps

With the conclusion of this route selection, the pipeline effort will transition from a desktop route study to a final surveyed alignment which will be used in the final design of all segments.

To date, the corridor and route studies have been primarily "desktop" studies using aerial photography, available records and databases, and readily available property data. In order to refine the route to the final alignment, significant field work will be required. In general, the following tasks will be performed in the conceptual design phase:

- Surveyors will research all boundary information for affected and potentially affected properties and provide a database of the landowner and property information.
- Landowner right of entry permission will be obtained on all properties the route crosses as well as adjoining properties. Permission to access adjoining properties may be needed in order to help facilitate minor re-routes around conflicts that are discovered in the field.
- Engineering, environmental, and archeological teams will walk the entire route and identify conflicts in the field. These conflicts will be analyzed and the alignment will be modified to avoid or mitigate the impacts. Subsurface Utility Engineering (SUE) will be required to locate existing utilities.
- Surveyors will establish project control for aerial photography and land survey, and provide photography and topographic survey.
- Once the alignment is established, easement documents will be provided to TRWD and Dallas for acquisition.

At the end of the conceptual design phase, the centerline of the proposed IPL will be established, along with corresponding 150 foot-wide right of way. This alignment will be used for the final design effort and environmental permitting.

Section 3
Facility Sites

This section of the report describes the proposed facilities for the Integrated Pipeline Project. The following table lists the facilities discussed in this section of the report.

Table 3-1. Summary of Facility Sites

Lake Palestine Pump Station	Anderson	150 MGD	Initial (pending Dallas decision)
Cedar Creek Lake Pump Station	Henderson	127 MGD / 190 Peak	Initial
Richland-Chambers Lake Pump Station	Navarro	70 MGD Initial / 250 MGD Future	Initial
Booster Pump Station 1 of 2	Navarro	350 MGD	Initial
Booster Pump Station 2 of 2	Ellis	350 MGD	Initial
Crowley Balancing Reservoir	Tarrant	200 MG Initial / 400 MG future	Delayed or Deleted with Crowley Tunnel

The timing of construction for all pump stations is contingent on the final phasing analysis to be completed in the conceptual design phase of this project. Timing of construction for the Lake Palestine Pump Station is contingent on Dallas' decisions as to the timing of their need for additional supplies. The Crowley Balancing Reservoir was proposed during the corridor selection phase of the project. The conclusion from recent studies is to build a tunnel through high ground in the Crowley area, thus possibly eliminating the need for the balancing reservoir. Because the decision as to building this tunnel will be refined in the Conceptual Design Phase, the description and site study for the balancing reservoir has been included in this report.

3.1 Lake Pump Stations

This section describes the three lake pump stations at Lake Palestine, Cedar Creek Reservoir and Richland-Chambers Reservoir. The lake pump station sites are well established based on previous studies. For lake pump stations, the optimum site would be on a steep bank on the lake shore that provides close access to deep water and high ground out of the flood pool. The site would also have good foundation soils. The optimum site would also be near public road access and close to high voltage power.

3.1.1 Lake Palestine Pump Station

The Integrated Pipeline begins at a proposed intake pump station site on the west side of Lake Palestine. The recommended location is approximately one mile north of the Blackburn Dam and was selected as part of the *Lake Palestine Utilization and Pipeline Alignment Study, June 1989*. The recommended property was purchased by Dallas based on the conclusions of that report. A location map of the Lake Palestine Pump Station is illustrated in **Figure 3-1**.

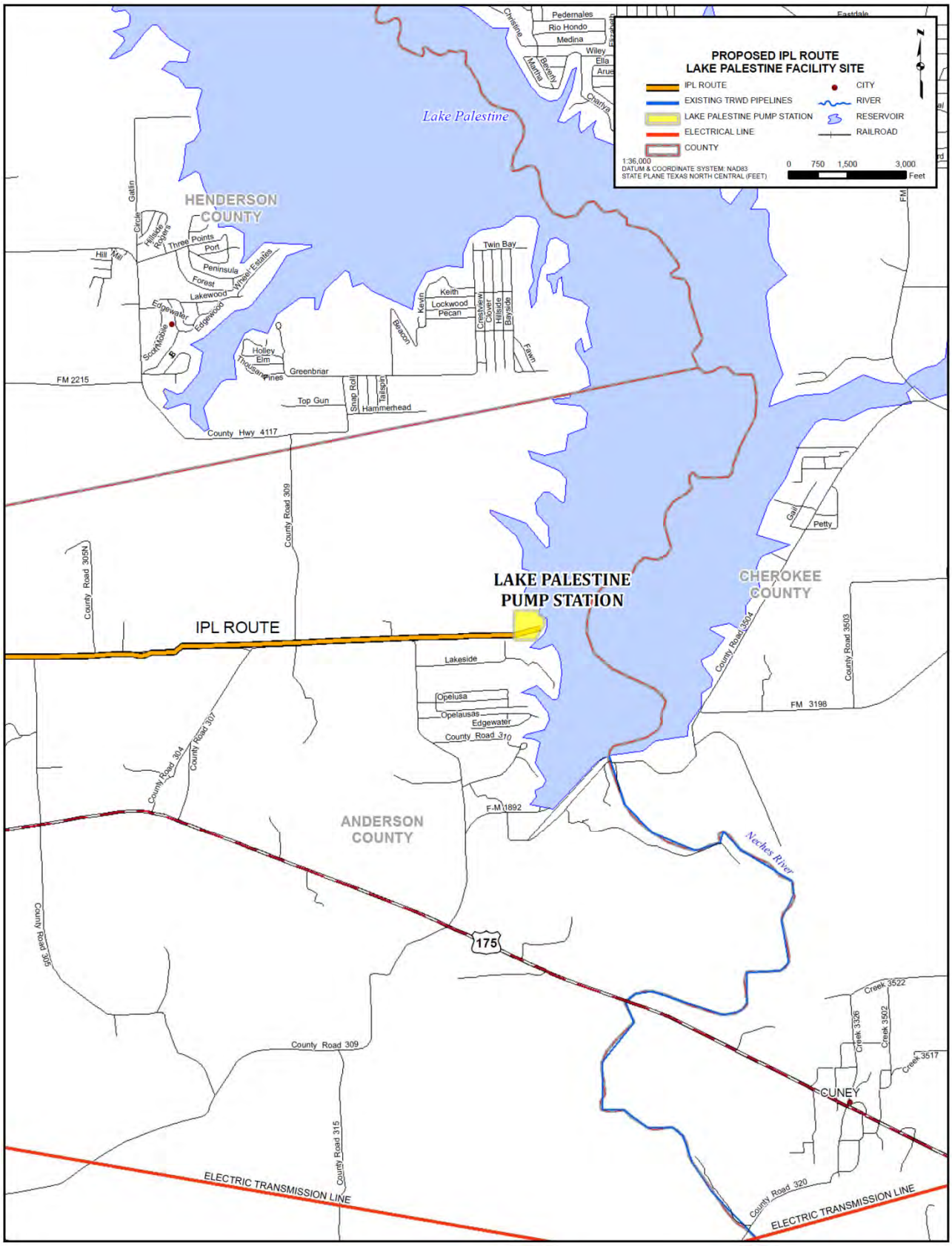

Figure 3-1. Lake Palestine Location Map

The selected site is adjacent to deep lake water, has good foundation soils, access to power, and has sufficient space to allow flexibility in the intake design. Deeper water at the pump station site will increase reliability. Other sites were explored to verify that the previously recommended site was the most preferred and this study recommends the same site.

Figure 3-1 shows that the pump station is located 1.5 miles north of U.S. Highway 175. Access to the pump station is off County Road 309, an existing two-lane asphalt road. It is anticipated that a new 3,000 foot long access road will be needed from C.R. 309 to the site. The access road would likely be constructed in the proposed pipeline easement.

The site is a wooded lot that fronts the southwest side of the lake. A photograph of the site is shown in **Figure 3-2**.

Figure 3-2. Photograph of the Lake Palestine Pump Station Site

Rayburn Electric Co-op has a 138 KV transmission line approximately 1.5 miles south of the recommended site. The electric transmission line runs from the northwest to the southeast and crosses Highway 175 about 3,000 feet west of the CR 309. It is anticipated that the power line can be routed along C.R. 309 and into the site paralleling the access road and pipeline. **Figure 3-1** shows the power line in relation to roads.

Lake levels are important design criteria influencing the location and layout of an intake pump station. **Table 3-2** is a summary of key elevations for Lake Palestine, based on information from the TWDB report "Volumetric Survey of Lake Palestine, June 2003 Survey".

Table 3-2. Key Elevations for Lake Palestine

Top of Dam	364.0
Design Water Surface (Flood Conditions)	355.3
Spillway Crest (Conservation Pool)	345.0
Low Flow Outlet (Drought Conditions)	309.5

The old river channel bottom has an elevation of 300 feet. According to the area and capacity curve for Lake Palestine in the TWDB "Engineering Data" report, an intake elevation of 315 feet will access 95 percent of the lake's storage capacity. In order to pull water from an elevation of 315 feet, it is anticipated that the pump will need approximately 10' of submergence; therefore an intake channel at an approximate elevation of 300-305 feet is preferred. In order to access such a lake bottom elevation, an intake channel approximately 1,200 feet in length is needed to be dredged to reach the old river channel. **Figure 3-3** shows an aerial map of the proposed lake pump station site along with contours from the 2003 TWDB Volumetric Survey.

In 1988, a boring was taken on the pump station by McClelland Engineers and is described in their letter report dated July 25, 1988. The boring at the site shows a 1-2 foot thick layer of silty sand at the surface. Beneath this sand, a stiff to very stiff sandy clay was present to a depth of 14 feet. A sand layer three feet thick overlaying the bedrock was encountered from 14 to 17 feet. A greenish gray carboneous shale was encountered at depths of 17 feet to 32 feet. A 6 to 8 foot thick layer of porous sandstone was present from 32 feet to 38 feet. Below the sandstone is another 36' of carbonaceous shale with layers of sandstone to a depth of 74 feet where the boring was terminated. McClelland reports that water was encountered at depths of 14 to 15 feet, near the top of the sandstone layer. Shortly after encountering the water, the level rose to depths of 3 to 8 feet which was above the lake level.

The proposed site is suitable for several intake options including the following:

- A dredged intake channel with a wet-dry pit on shore that houses horizontal split-case pumps at the bottom of the pit, similar to DWU's Lake Fork Pump Station.
- A dredged intake channel to a sump pit on the shore with vertical turbine pumps set above the wet-well.
- A platform type pump station with vertical turbine pumps in the lake with a dredged channel to reduce the length of the bridge deck, similar to TRWD's Benbrook Lake Pump Station.
- A sump pit constructed on shore with intake pipes bored or tunneled into the lake with a dredged channel to the intake screens to reduce pipe length.

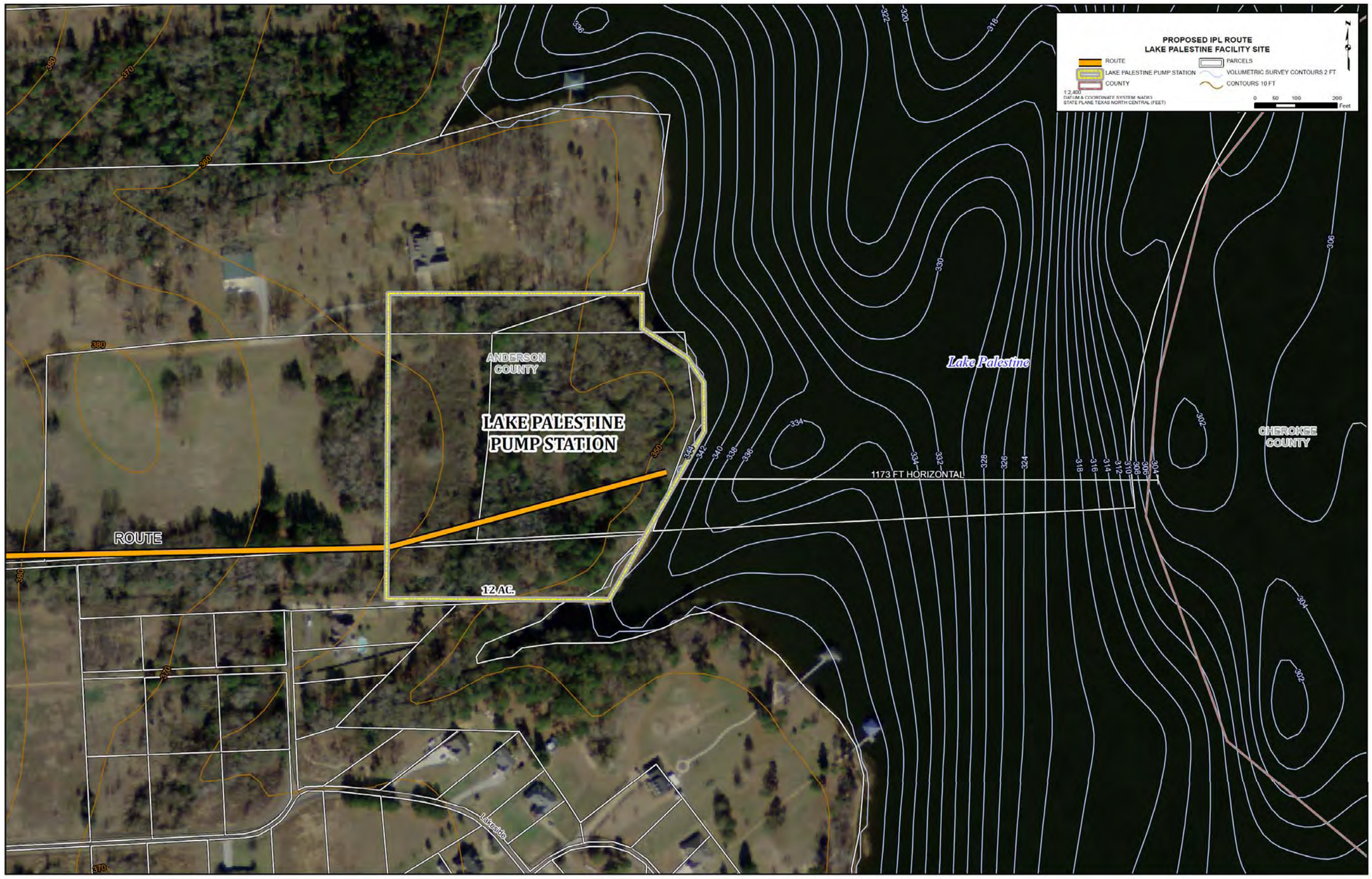

Figure 3-3. Lake Palestine Site Map

These options along with others should be evaluated in the conceptual design phase to determine the best layout in terms of capital costs, environmental impact, reliability, maintenance requirements and owner preference.

Future steps in the conceptual design phase should include geotechnical work and survey. Additional geotechnical borings are required on the site and in the lake. A topographical survey and a bathymetric survey are also recommended early in the conceptual design phase to facilitate layouts.

3.1.2 Cedar Creek Pump Station

Cedar Creek Reservoir supplies 127 MGD to the Integrated Pipeline through pipeline Segment E. Lake Pump Station sites were studied on both the east and west side of the reservoir during the corridor study. The selected pump station site is on the west side of the reservoir, approximately 1.5 miles north of the main transmission pipeline. The site is a large wooded area near the dam with adequate room for construction staging and is owned by TRWD. **Figure 3-4** shows a location map of the proposed Cedar Creek Pump station.

TXU/Oncor transmission lines are located 5,000' from the proposed pump station site. The nearby electric transmission lines provide 69 KV, 138 KV, and 345 KV and can be seen in **Figure 3-4**. State Highway 274 is located almost a mile southwest of the site. Mankin Road can be taken from SH 274 to get within half a mile of the site. Mankin Road connects to Key Ranch Road to the north and Forehand Road to the east. An access road must be constructed either from Mankin Road, Forehand Road or Key Ranch Road to access the pump station site.

Data on Cedar Creek Reservoir was obtained from the Texas Water Development Board "Report 126 - Engineering Data on Dams and Reservoirs in Texas, Part II". The TWDB "Engineering Data" shows that the lake is impounded by Joe Hogsett Dam, elevation 340.0 feet above mean sea level. The 100-year flood elevation for Cedar Creek Reservoir is 325.0 feet at the top of the spillway gates. Conservation pool level is 322.0 feet. It is recommended that the proposed pump station be located at a site with an elevation several feet above 325 feet MSL, preferably closer to 334 feet to match the flood protection of the existing TRWD pump station which is located further north along the lake shore.

The Texas Water Development Board performed a bathymetric survey in July of 2005 for the purposes of determined the volume of the reservoir. Based on the survey and volume calculations, the following distances from the site shoreline to various contours are listed along with the storage available at each elevation.

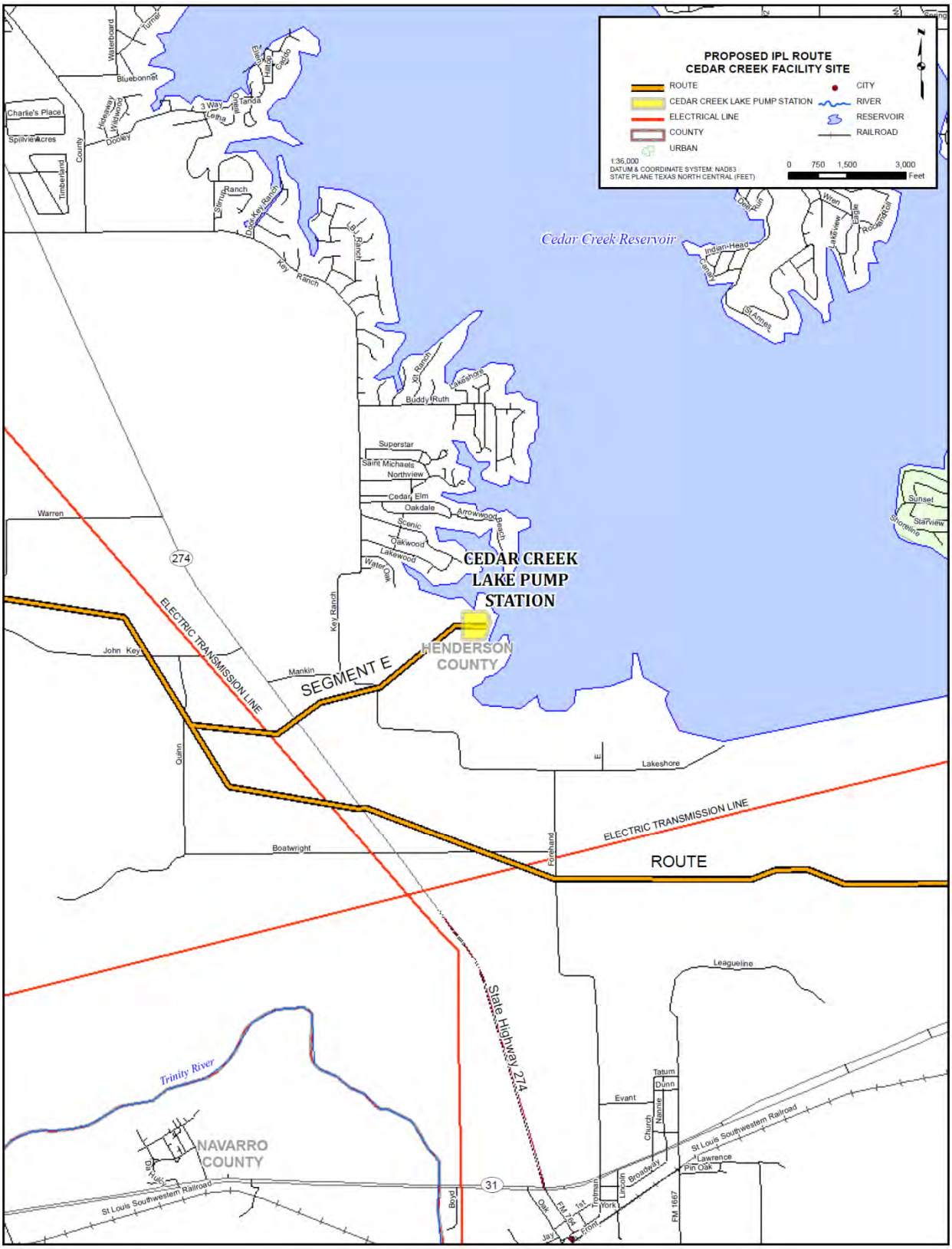

Figure 3-4. Cedar Creek Facility Site Location

Table 3-3. Cedar Creek Intake Channel Criteria

Elevation	Distance to Elevation (Feet)	Storage Capacity (ac-ft)	Percent of Storage Capacity
270	4,200’	1,264	99.80 %
275	2,200’	4,978	99.22 %
280	2,000’	14,257	97.76 %
285	1,100’	37,182	94.16 %
322	0	637,180	

According to the storage capacity table for Cedar Creek Reservoir in the TWDB April 2007 Report, an intake channel with a bottom elevation of 285 feet will access 94.2 percent of the lake’s storage capacity. An intake channel bottom elevation of 280 feet will access 97.7 percent of the lake’s storage capacity. Since the existing intake pump station can access water down to 275.0 feet, it seems access to 280.0 feet is adequate; however a deeper intake channel may be required to pump down to elevation 280.

A trapezoidal drainage channel runs east-west along the south side of the proposed pump station site. The soils excavated from this channel raised the site above the lake flood level. The preferred pump station site elevation is above the 330-foot contour line according to USGS maps of the area. Flood level for the lake is 325 feet. This proposed site is heavily wooded but is not located near any residential areas and the proposed pump station site is large enough for multiple pump station layout options. See **Figure 3-5** for site details.

Similar to the Lake Palestine site described above, the proposed Cedar Creek Lake Pump Station site is suitable for several intake options including the following:

- A dredged intake channel with a wet-dry pit on shore that houses horizontal split-case pumps at the bottom of the pit, similar to DWU’s Lake Fork Pump Station.
- A dredged intake channel to a sump pit on the shore with vertical turbine pumps set above the wet-well.
- A platform type pump station with vertical turbine pumps in the lake with a dredged channel to reduce the length of the bridge deck, similar to TRWD’s Benbrook Lake Pump Station.
- A sump pit constructed on shore with intake pipes bored or tunneled into the lake with a dredged channel to the intake screens to reduce pipe length.

It may be possible to use the trapezoidal drainage channel as part of the intake channel for the proposed pump station. The channel will need to be enlarged but may reduce the amount of dredging required to reach the proper elevation. A bathymetric survey is recommended for this site to verify lake depths as well as borings on land and in the lake.

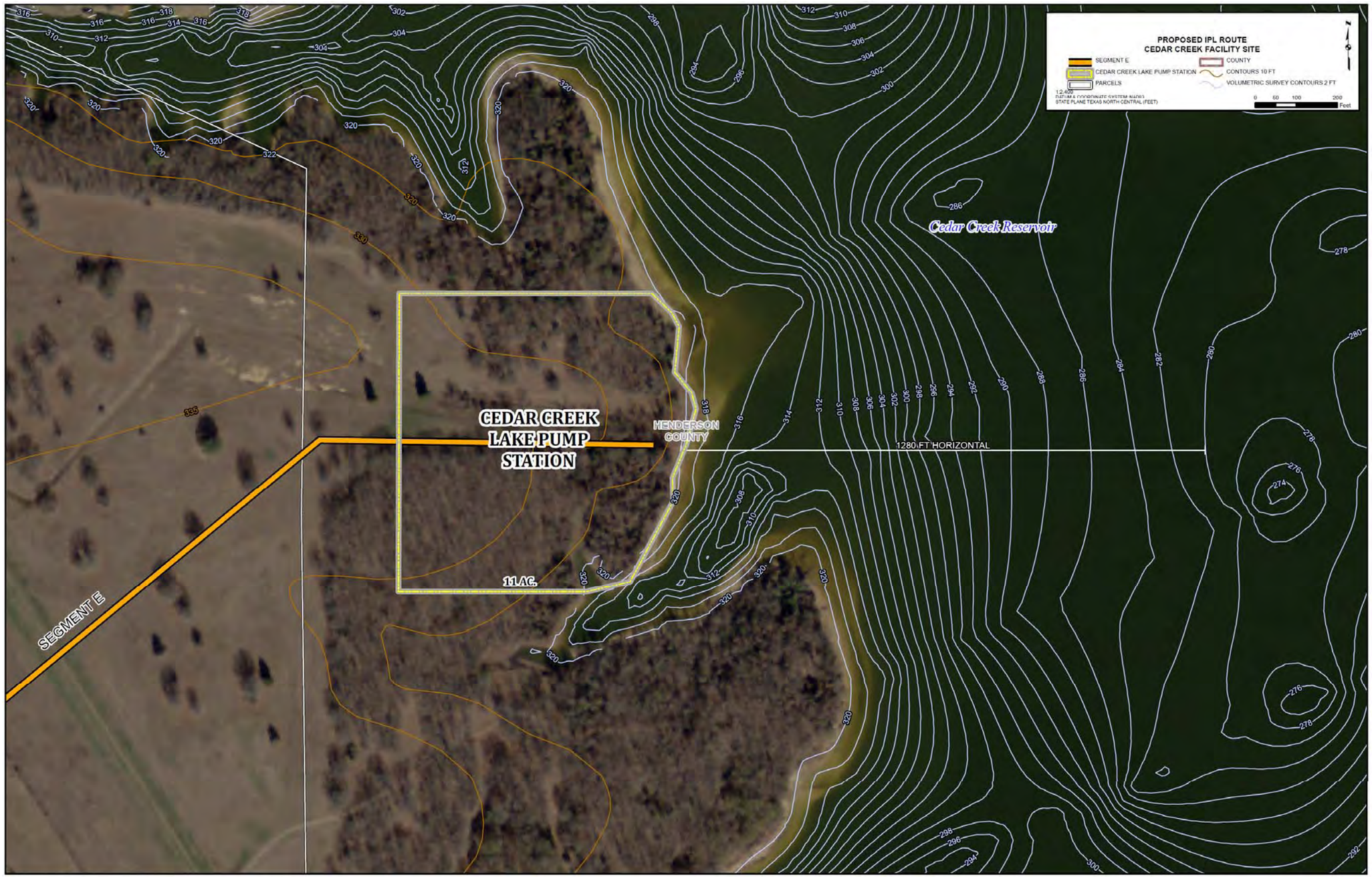

Figure 3-5. Cedar Creek Facility Site

3.1.3 Richland-Chambers Pump Station

Tarrant Regional Water District constructed the Richland-Chambers Project between 1984 and 1989. The intake facilities were constructed in 1985, before the lake was completed. The pump station was bid in 1987 and completed in 1989. The pump station is located on the northern shore of Richland-Chambers Reservoir. Access to the pump station is off State Highway 309 between S.H. 31 and U.S. 287 east of Corsicana. County Road 3250 provides access to the site. A location map is shown as **Figure 3-6**.

The intake facilities include an intake tower in the lake and two 14' square conduits connecting the intake tower to the sump on the shore. The 106'x69' sump was built on the shore with the intake facilities. The intake tower was designed for an ultimate capacity of 480 MGD at a velocity of less than 2 fps. Currently only one of the 14' conduits is connected to the existing sump. The facility was master planned for a future pump station to mirror the existing sump and pump station. The end of the northern conduit has a block out that will ultimately connect the future sump to the conduit. The two conduits can be isolated with stop gates on the intake tower.

The existing RC Lake Pump station has six 5500 HP pumps, each rated to pump 50 MGD at 529 feet of head. Three pumps are used in low capacity operations to move 147 MGD while 5 pumps are used in high capacity operations to move 250 MGD.

It is anticipated that the future pump station will also include six pump slots; however, it is not anticipated that all slots will be used for the proposed 70 MGD capacity of the Integrated System. The site includes space for the new pump station and a new substation. A site plan of the pump station site is shown on **Figure 3-7**. The location of the future pump station and the future substation is identified.

The existing 90" Richland-Chambers Pipeline runs in a northerly direction leaving the pump station site. The pipeline ROW is 180' wide. The pipeline is off-set 25' to the east of the easement centerline, 115' of the west side of the easement. A 4" waterline runs 5' off the west easement line and a 138kV power line runs 5' to 10' inside the eastern edge of the easement.

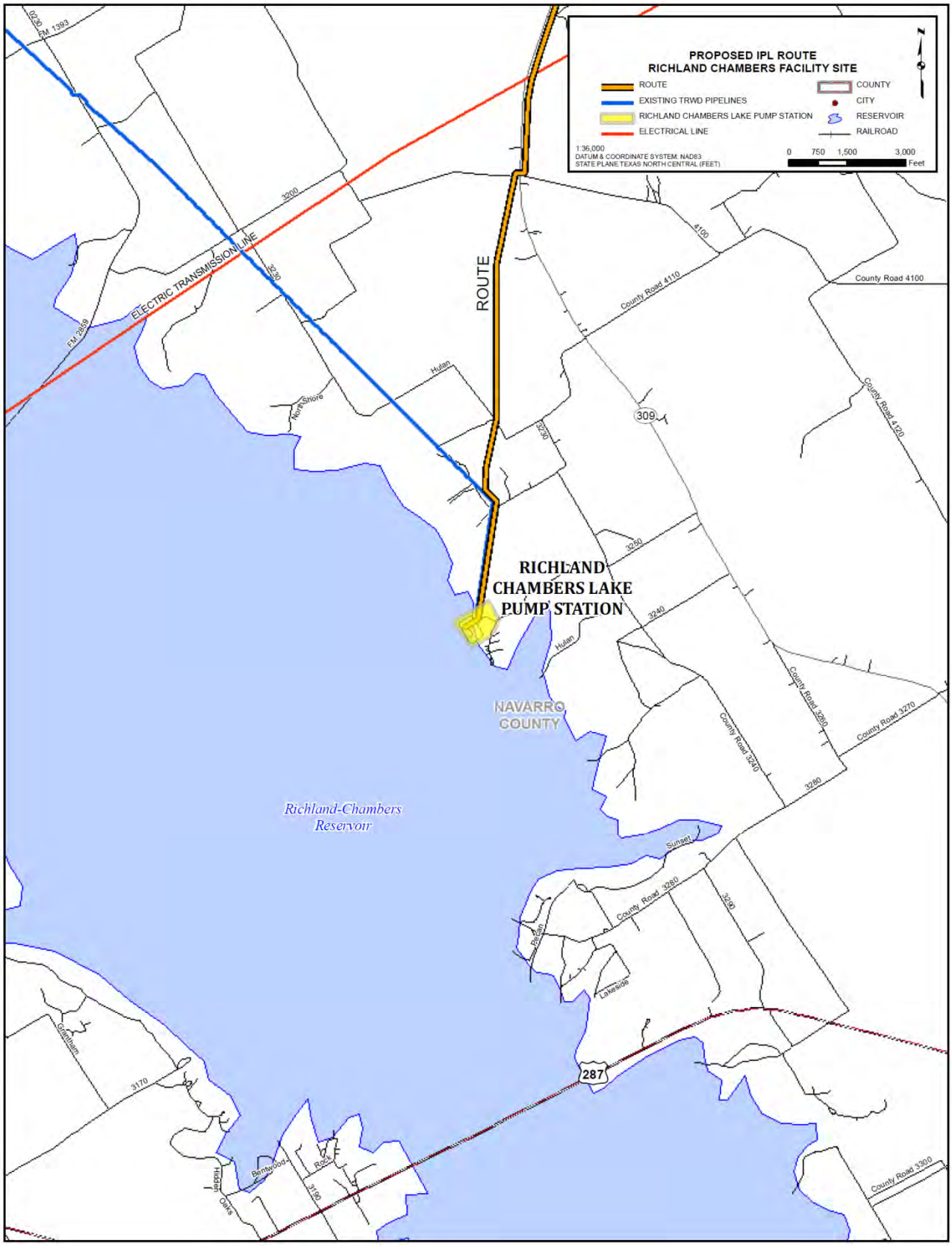

Figure 3-6. Richland-Chambers Facility Site Location

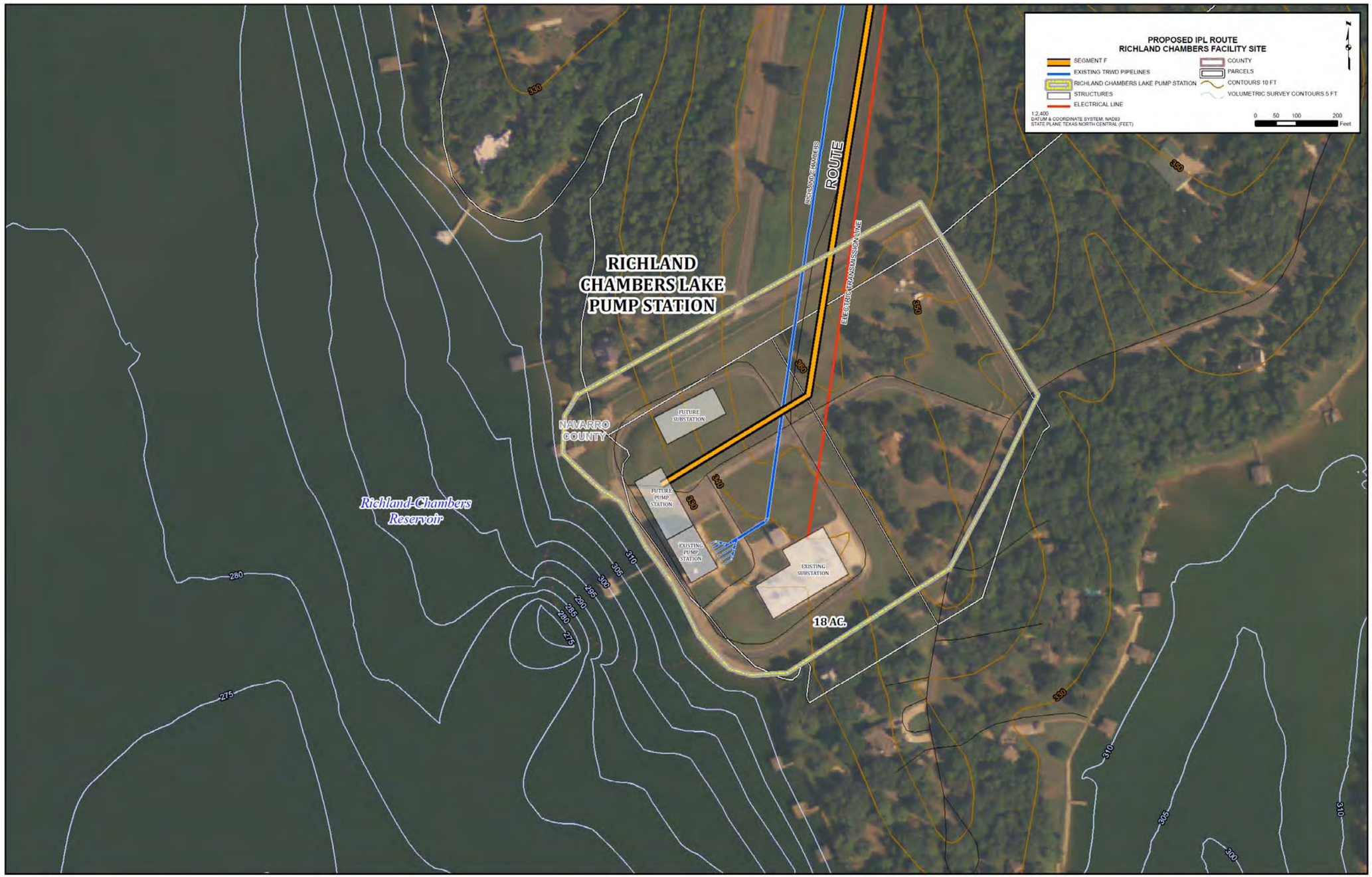

Figure 3-7. Richland-Chambers Pump Station Site Layout

3.2 Booster Pump Stations

Two booster pump stations are recommended along the main pipeline corridor to pump water west to TRWD and Dallas. The following section describes the two booster pump station (BPS) facilities. For each booster pump station, two alternate sites were chosen and evaluated with a recommendation made as to the preferred site. Evaluation criteria include access, proximity to power, soil conditions, hydraulics and ease of operations.

3.2.1 BPS 1 of 2

Two sites were considered for the location of BPS 1 of 2. Both options are located within Segment C between the Segment F Connection and I-45. The two options identified for the location of BPS 1 of 2 are referred to as:

- BPS 1 of 2, Site A
- BPS 1 of 2, Site B

A map showing the location of both options can be seen in **Figure 3-8**. The two site options are separated by approximately 15,000 LF along the proposed pipeline with option A as the more eastern and option B as the more western of the two. The existing TRWD Richland-Chambers Pipeline crosses in between these two options.

BPS 1 of 2 A

Site A, the more eastern, is located on the west side of FM 1129, near the intersection of FM 636 at Station 2990+00 of the IPL. The site is located directly off of FM 1129 and is due south of an existing electrical substation as seen in **Figure 3-9** which shows a photo of the proposed site.

Site A is bound by FM 1129 to the southeast and an electrical transmission right-of way to the north. The substation is located to the northeast of the site with a small pond immediately to the south of the substation. This end of the site has an elevation of 460 feet. The exact layout and location of the site depends on the type of storage facility chosen. Two options have been considered:

- Ground storage tanks may be preferred hydraulically to try and match the high points on Segment A of the pipeline. It is anticipated that the top of pipe can be set at an elevation of 525. The storage tanks could have a bottom elevation of 450 and a top elevation at 525 to keep the pipeline full and prevent the line from draining into and overflowing the tanks. The downside is the cost of taller tanks and the number of tanks that would be required to provide the adequate storage to ride through a power outage at one pump station site.
- An alternate operational concept is to build an earthen reservoir for increased storage to allow one pump station to ride though a power outage at another site. For large volumes of storage, an earthen reservoir is more cost effective. The downside is that the optimum embankment may only be 30 to 40 feet in height. As this site may have a bottom elevation of 440 feet MSL, the maximum water surface elevation for this reservoir may be only 470-480 feet. Enough freeboard could be built into the reservoir to allow water from the highpoint to drain into the reservoir, or an alternate means of keeping the pipeline full could be used such as a stand pipe.

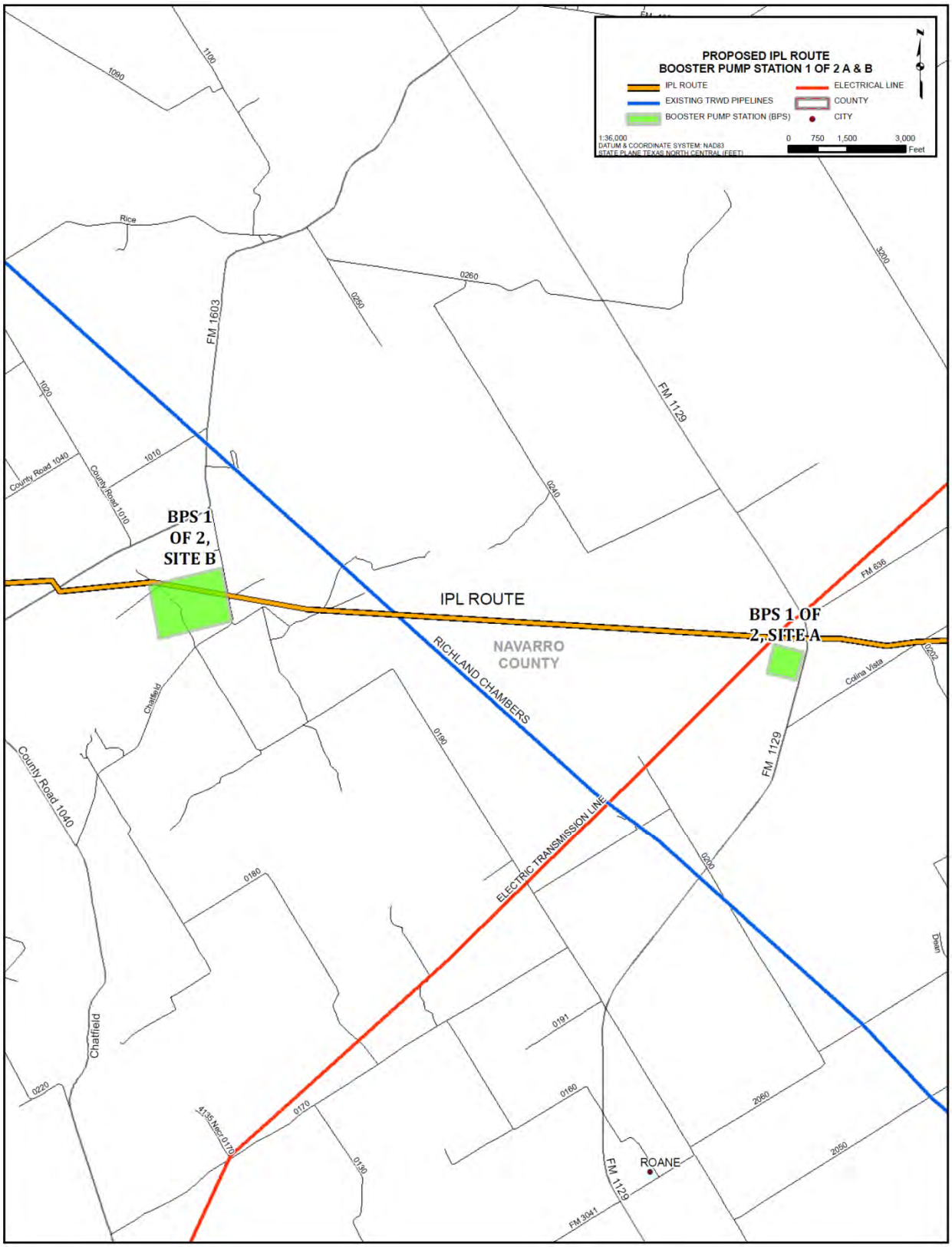

Figure 3-8. BPS 1 of 2 Location Map

If ground storage tanks are preferred, then the limits of the site should be shifted as far east as possible to take advantage of the high ground on the northeast corner and the proximity to the electrical substation. If an earthen reservoir is preferred, then the limits of the site can be shifted west to provide for more room between the highway and the electrical transmission line. See **Figure 3-10** for site details with the possible site boundaries and contours.

Figure 3-9. BPS 1 of 2, Site A, Facing West

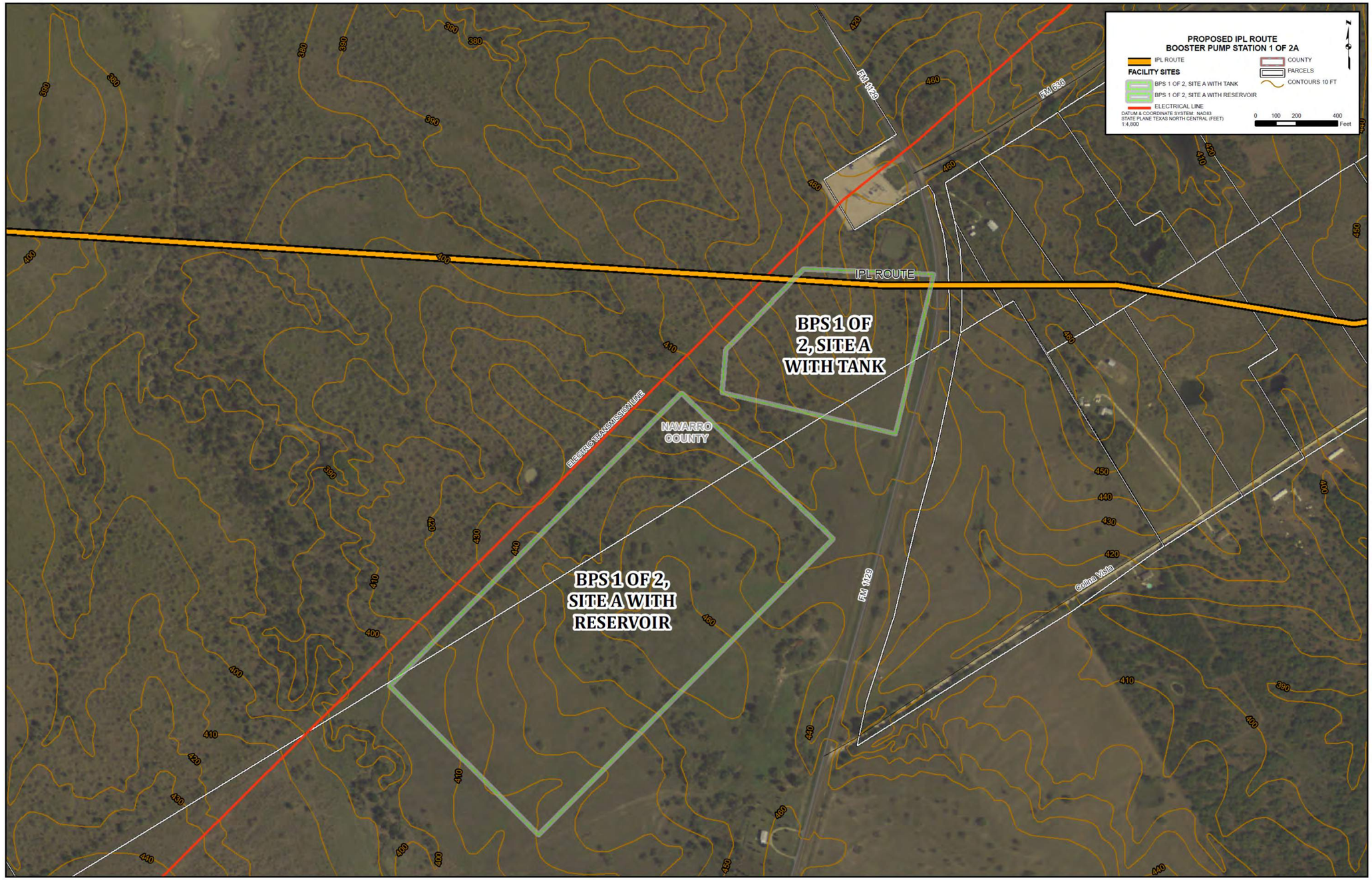

Figure 3-10. Site Layout of BPS 1 of 2 A

BPS 1 of 2 B

Site B is located in a field, approximately 0.3 miles south of FM 1603, directly off of Chatfield Road. The site is near Station 3140+00 of the IPL. **Figure 3-11** shows a photo of the proposed site. The black line shows the site boundary. Included inside of the site boundary will be the reservoir and pump station.

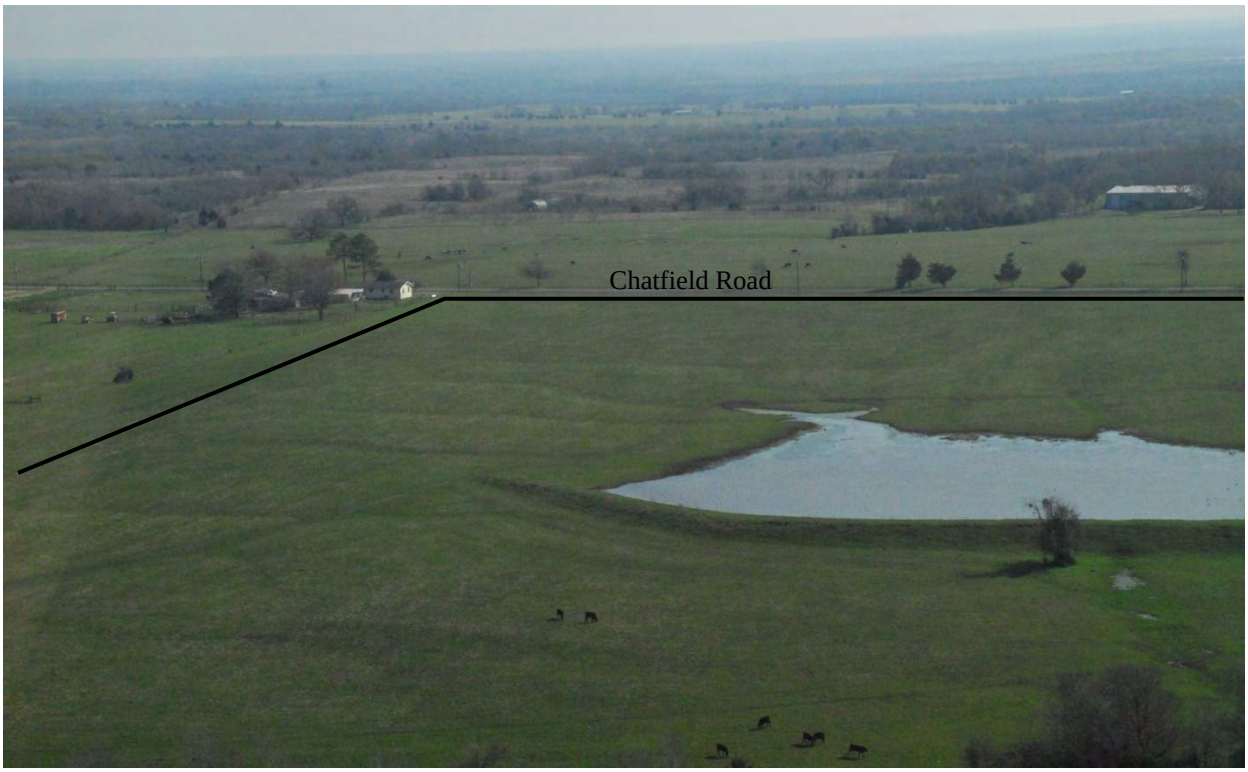

Figure 3-11. BPS 1 of 2, Site B, Facing East

Option B is on a large, relatively flat area that will allow for an earthen reservoir and pump station. The proposed site is approximately 61 acres, providing room for a 1,200 foot by 1,200 foot earthen reservoir. The footprint of the reservoir may be decreased, while maintain volume, pending site specific cut and fill requirements. An existing earthen tank is located in the middle of the site and will need to be removed during construction of the reservoir. **Figure 3-12** illustrates the boundary and topography of the proposed site.

Due to its location relative to the existing RC pipeline, this site allows multiple operating scenarios. The typical arrangement is for the pipeline to feed into the reservoir and then gravity flow into the suction side of the booster pump station. A line is needed to bypass the reservoir to connect directly to the suction side of the pump station. This will allow pumping when the reservoir is down for maintenance. A standpipe could be installed on this leg to control system pressures. A bypass around the reservoir and pump station will also be needed to allow pumping directly from the lakes to the second booster pump station. Lastly, a pipeline could be built back to the RC pipeline, approximately 4,800 feet, to allow for pumping through either the proposed IPL or the existing 90” RC line.

Site B is located on the west side of the connection to the RC Pipeline. This allows for water from Richland-Chambers to be pumped to BPS 1 of 2 and continue on to Benbrook or to be routed back to the RC Pipeline and potentially bypass the Ennis Pump Station.

The pump station may have either horizontal or vertical turbine pumps and will be located downstream of the reservoir at a lower elevation to allow the reservoir to drain completely.

Comparison of BPS 1 of 2 Sites

Property - Site B holds size advantages as it is larger in area than Site A. Site A is limited due to the restriction of the electrical transmission line on the northern boundary of the site. Although an earthen reservoir could be built on either site, Site B lends itself more to reservoir construction.

Geology - A preliminary analysis of the soils and geology in both locations was performed. The National Cooperative Soil Survey and the Geologic Atlas of Texas were used for the analysis. The soil for Site A is mostly comprised of clay. The main issue for concern with the clay at Site A is the soil's propensity to shrink and swell. For the tank, there will need to be possibly 10 to 15 feet of excavation and backfill for site improvement to prevent any shrinking and swelling. The soil for Site B is comprised of multiple soil types with the majority being sandy loam. Shrink and swale is less of an issue for Site B than Site A. The soil type is favorable for a reservoir on Site B; however, if the reservoir is cut deep enough, it may encounter a sandy formation which could cause water loss. The use of a clay or synthetic liner can be used to prevent this from occurring. There is not much difference between how the soils at the different sites will affect the pump station, but the soils at Site B are slightly more favorable.

Access - Site A has great access to a nearby power source and is directly off of an FM highway. Site B also has good access to roads, as it is situated directly off of Chatfield Road which intersects FM 1603 approximately 0.3 miles north of the facility site. However, the closest electrical substation to Site B is approximately 3 miles to the east.

Operations and Hydraulics - The ability for Site B to have a reservoir greatly increases its operation and storage capabilities. In general, the further west the booster pump station is located, the less pipe above 250 psi is required downstream of BPS 1 of 2. See **Figure 3-13** for the hydraulic profile showing the pipe pressure. Furthermore, with Site B on the west side of the RC Pipeline connection, water from the Richland Chambers Reservoir can be pumped to the reservoir at Site B and through the IPL.

There are several high points along the pipeline that are upstream of both sites and reach higher elevations than both sites. One high point is at elevation 550 feet MSL while the others are at 530 feet MSL.

The bottom of the tank at Site A would be at an elevation of 450 feet MSL. With an 80 foot tall tank, the max elevation of the tank will be 530 feet MSL to match several of the high points upstream. If Site A is chosen for BPS 1 of 2, the high point which reaches an elevation of 550 feet will have to be deep cut to an elevation of 530 feet for approximately 1,000 feet along the IPL. This will ensure that the tank at Site A does not overflow during pump stoppage.

Figure 3-12. Site Layout of BPS 1 of 2, Site B

It is anticipated that the reservoir at Site B will be approximately 30 feet tall with a ground elevation of 460 feet MSL and a max water level of 490 feet MSL. Note that the elevation of the pipeline upstream of Site A rises above 490 feet MSL. When pumps are not running, the water in the pipeline above 490 feet will flow by gravity to the reservoir causing potential overflow events. However, overflow can be prevented with sufficient freeboard in the reservoir. The high points along the pipeline create valleys that will store the water and remain full. In the event of a power outage, water remains inside the valleys and drains from only a portion of the pipeline. The total volume of water in the pipeline that will not be contained in valleys, but will feed into the reservoir is slightly over 1MG. With a reservoir having an inside perimeter of 1,000 feet by 1,000 feet, the freeboard required to prevent overflow is less than two inches. **Figure 3-13** features the hydraulic grade line of the pipeline from Lake Palestine to BPS 1of 2 and it shows the valleys created by the high points.

If freeboard is used on the reservoir at site B for water to drain into, the 550 foot high point will not need to be deep cut. Using freeboard at Site A requires the water tank to be approximately 250 feet in diameter which rules this operation scenario out. Thus, if site A with a tank is selected, the high point reaching 550 feet MSL upstream of the site must be deep cut for 1,000 feet.

Utilizing freeboard as discussed for site B results in portions of the pipeline being dewatered during pump stoppage. This necessitates special considerations during the start up of pumps while filling the pipeline. If avoiding dewatering of lines is preferred during pump stoppage, a standpipe with an overflow weir could be implemented at site B. A standpipe is required to hold water at an elevation of 530 feet MSL resulting in an approximate 70 foot height. During normal operation the standpipe is bypassed to lower static head. During pump stoppage, the bypass valve is closed to prevent dewatering the pipeline. Like Site A, a standpipe at site B requires upstream pipe to be deep cut so as not to exceed an elevation of 530 feet.

Recommendation

Site A holds power access advantages as it is next to an electrical substation. However, due to hydraulic advantages including the ability to better utilize the RC connection and the ability to house a reservoir, site B is preferred. **Table 3-4** outlines a comparison of the two options. An "x" indicates which site is preferred per category. If both options are marked with an "x" they are considered equal.

Table 3-4. Comparison of BPS 1 of 2

Criteria	Site A	Site B
Operations		x
Hydraulics		x
Size		x
Elevation		x
Road Access	x	x
Power Access	x	
Geology		x

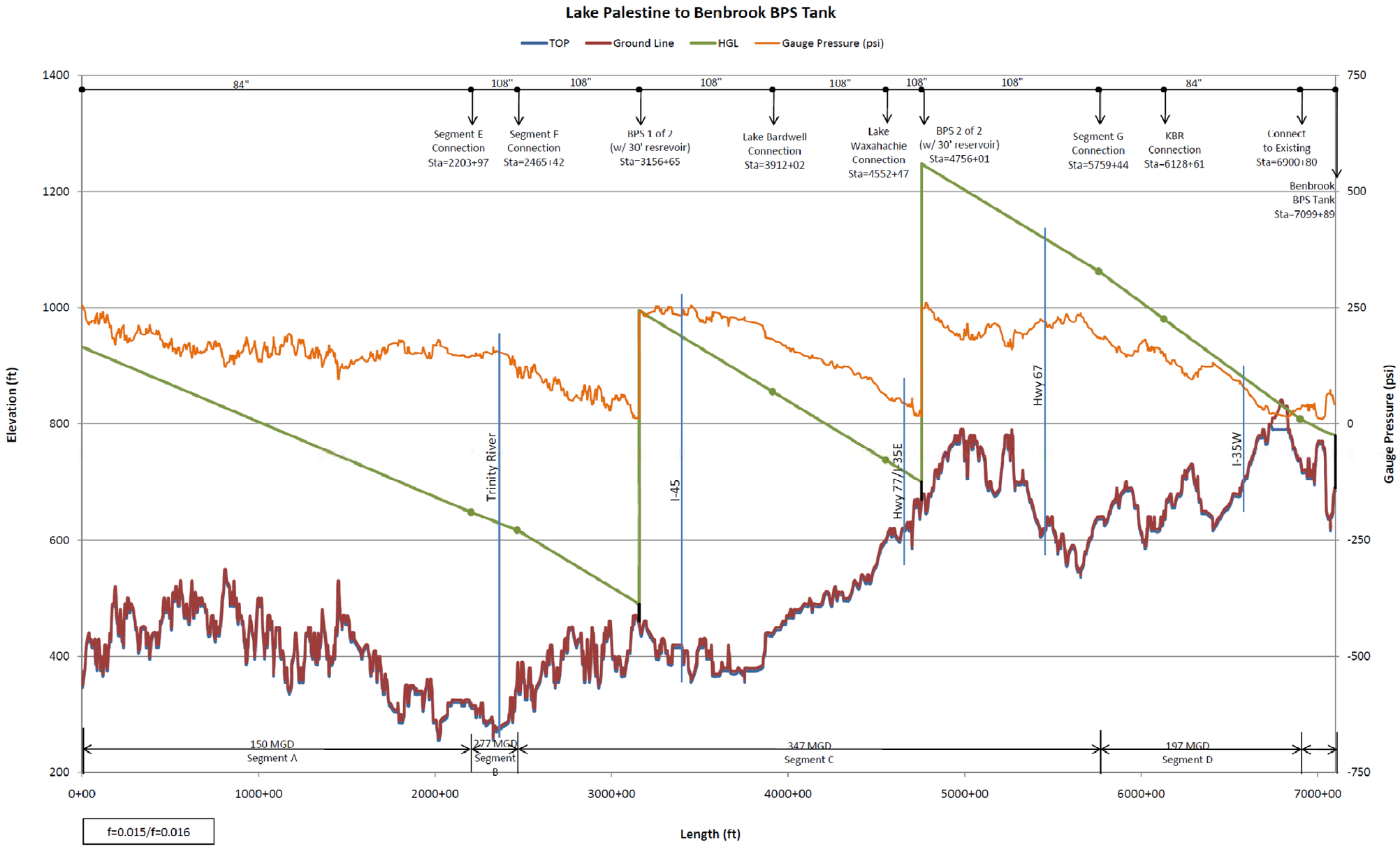

Figure 3-13. HGL for IPL from Lake Palestine to Benbrook BPS Tank

3.2.2 BPS 2 of 2

The second booster pump station is also located on Segment C of the pipeline, approximately three to four miles west of I-35E. This is roughly four miles southwest of Waxahachie. See **Figure 3-14** for location details. There are two possible sites identified for this booster pump station:

- BPS 2 of 2, Site A
- BPS 2 of 2, Site B

The sites are about a mile apart, separated by FM 66. Site A is the eastern most while site B is the western of the two options. The elevation of the pipeline route in this area is climbing towards a high point near Midlothian which is about ten miles further northwest along the route. The Midlothian highpoint is approximately 790 feet MSL. A substation is located approximately 4.5 miles southwest of the sites where a transmission line and FM 66 intersect as seen in **Figure 3-14**. Both sites are approximately 130 acres in size to accommodate a BPS and a reservoir. The reservoir will be approximately 1,200 feet x 1,200 feet with 30 feet of water depth and five feet of freeboard resulting in a capacity of 90 MG which provides 6 hours of storage at a demand of 350 MGD. The footprint size is worst case and could likely be reduced pending site specific layout and detailed cut and fill balance.

C7 BPS 2 of 2, Site A

Site A is located southeast of FM 66. Access could be obtained by turning southeast off of FM 66 onto Cunningham Road. Cunningham Road would be followed for 0.3 miles before turning southwest onto Old Maypearl Road. The BPS site is located 1,000 feet down Old Maypearl on the southeast. Old Maypearl curves around the site bounding two sides. Thus, multiple access options are possible.

The selected site is an approximate 2,400’ x 2,400’ cultivated field. The surrounding area is rural pasture and cropland with development primarily along FM 66. Adjacent land could be available if future expansion is anticipated.

The site slopes from 690 feet MSL to 640 feet MSL. A reservoir on the site could have a bottom elevation of approximately 660 feet while the pump station could be built at elevation 650 feet. This would require the reservoir being in the southwest portion of the site to keep it as high as possible. The pump station is laid out to be in the northeast portion of the site to keep it as low as possible. See **Figure 3-15** for site details including contours. Such a configuration, with the bottom of the reservoir above the pump station, would allow the full capacity of the reservoir to be utilized and would improve pumping performance. Also, designing the pump station to be lower than the reservoir would broaden pump choices allowing the use of either horizontal or vertical turbine pumps. If a tank were implemented in place of an earthen reservoir, the site size could be reduced.

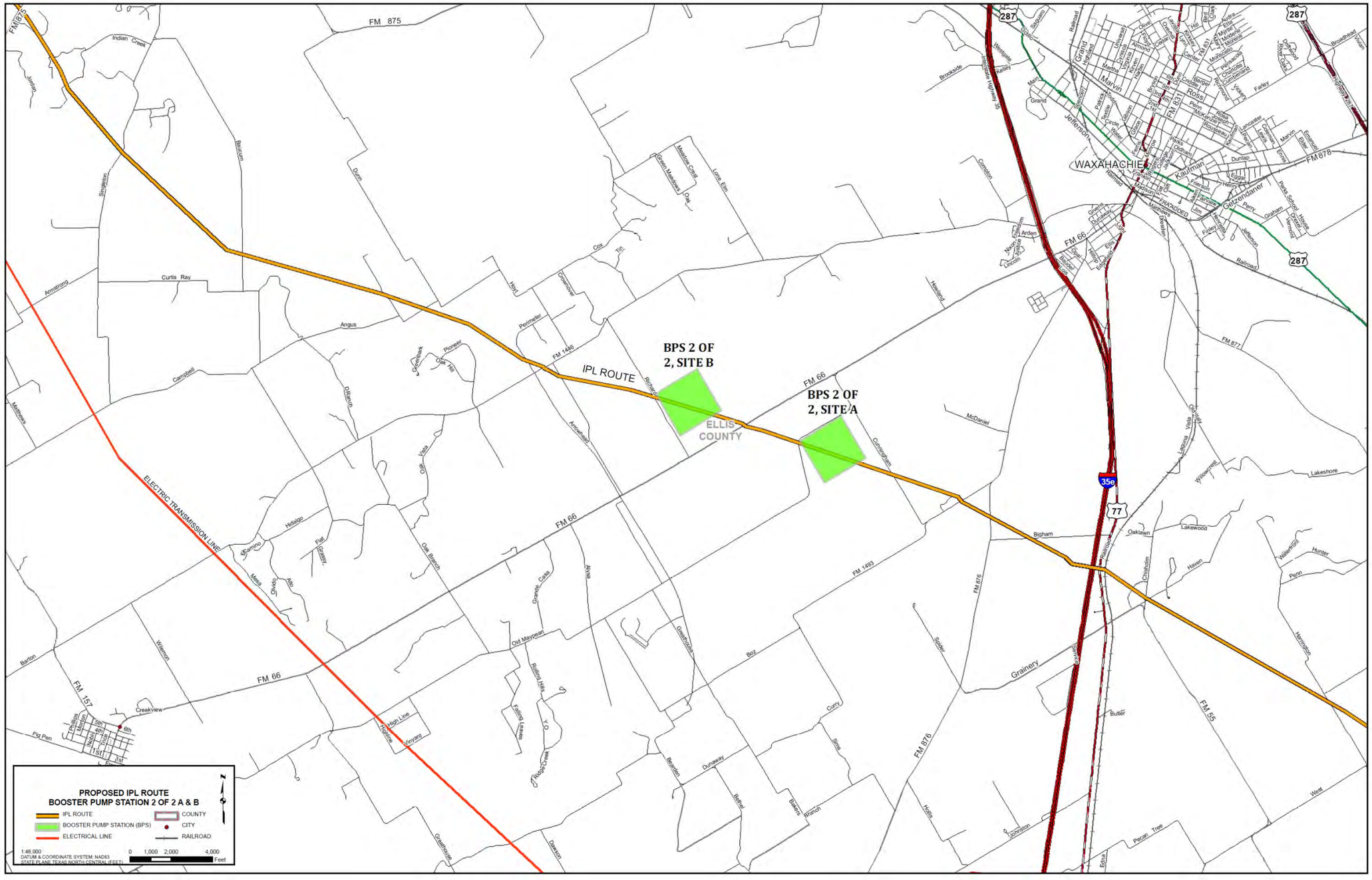

Figure 3-14. BPS 2 of 2 Location Map

Figure 3-15. BPS 2 of 2 A Site Layout

C7 BPS 2 of 2, Site B

Site B is situated northwest of FM 66. It can be accessed by turning northwest from FM 66 onto Richard road. The site is approximately 1,200 feet down Richard on the northeast side of the road.

Like site A, site B is approximately 2,400' x 2,400' in size. It is situated on pasture with the surrounding area also being rural pasture. Adjacent land could be available if future expansion is anticipated.

The site slopes from elevation 740 feet to 680 feet. Similar to site A, a reservoir could be built in the southeast corner while the pump station would be built in the northwest corner. See **Figure 3-16** for site details with contours. The bottom of the reservoir would likely be at elevation 700 feet with the pump station at elevation 690 feet. The full capacity of the reservoir could be utilized and the elevation difference between the reservoir and pump station would benefit pump performance. If a tank were implemented in place of an earthen reservoir, the site size could be reduced.

Comparison of BPS 2 of 2 Sites

Property - Both sites are almost identical in size and shape. According to the Natural Resources Conservation Service (NRCS), both sites are composed almost entirely of Austin silty clay as classified by the National Cooperative Soil Survey. Clay soil is preferred for earthen reservoirs. Thus, both sites are expected to be feasible from a geological perspective if an earthen reservoir is selected.

Access - Site A is slightly further off of FM 66, but the pump station is situated close to the front of the property. This results in a short access road that would need to be built on the property. The pump station on Site B is located back away from the road requiring the construction of a much longer access drive. The sites are very similar from a power aspect.

Operations and Hydraulics - The pump station at Site A is located about 50 feet lower in elevation than site B. As seen by the hydraulic profile, **Figure 3-13**, lowering the elevation is preferred. This would decrease the pressure in the pipeline segment between the two booster pump stations where the pressure class reaches above 250 psi.

Figure 3-16. BPS 2 of 2 B Site Layout

Recommendation
The two proposed sites are very similar and offer many of the same benefits. Once the sites are evaluated in detail on the ground, more information may become available setting one substantially better than the other. Currently site A is preferred and recommended. This is primarily due to the vertical advantages and shorter drive length. **Table 3-5** outlines a comparison of the two options. An "x" indicates which site is preferred per category. If both options are marked with an "x" they are considered equal.

Table 3-5. Comparison of BPS 2 of 2

Criteria	Site A	Site B
Operation	x	x
Hydraulics	x	x
Size	x	x
Elevation	x	
Road Access	x	
Power Access	x	x
Geology	x	x

3.3 Storage

3.3.1 Crowley Terminal Storage Reservoir

The Crowley reservoir site is located near the end of IPL segment D approximately 0.5 miles east of where Old Granbury road and Rocky Creek Park road meet. The site is an alternate option in the case that the Crowley deep tunnel is not built. In such an instance, the IPL will route south of the Crowley High School before turning north to make the Benbrook pipeline connection. The reservoir site is located west of the anticipated Southwest Parkway toll road. See **Figure 3-17** for site location.

The site is sized at 2,860 feet by 1,620 feet or approximately 105 acres. The site allows room for two 200 MG reservoirs. One reservoir would be built initially providing one day of storage. The second reservoir would be built later as system demands grow.

The site is located on rural pasture and could be accessed using FM 1902 which is just west of the site. The site is at elevation 870 feet MSL. According to NRCS, the site soil is classified by the National Cooperative Soil Survey as 50% Purves clay and 33% Aledo gravelly clay loam. The remainder of the soil composition is composed of Medlin and Sanger clay.

The Crowley reservoir option offers several operational benefits as listed below:

- Provides a full day storage in case of system downtime.
- Allows for constant pumping rates with changes in demand patterns absorbed by storage.
- Open water surface provides a surge break.
- Open water surface limits system from over pressuring due to accidental control valve closures.
- Provides a delivery point for the future Southwest WTP proposed by Fort Worth.

- Allows for delivery by gravity to Benbrook Outlet Structure, Clear Fork Outlet Structure, Benbrook Water Authority, Weatherford PS, Benbrook BPS, Rolling Hills WTP, and the Kennedale Balancing Reservoir.

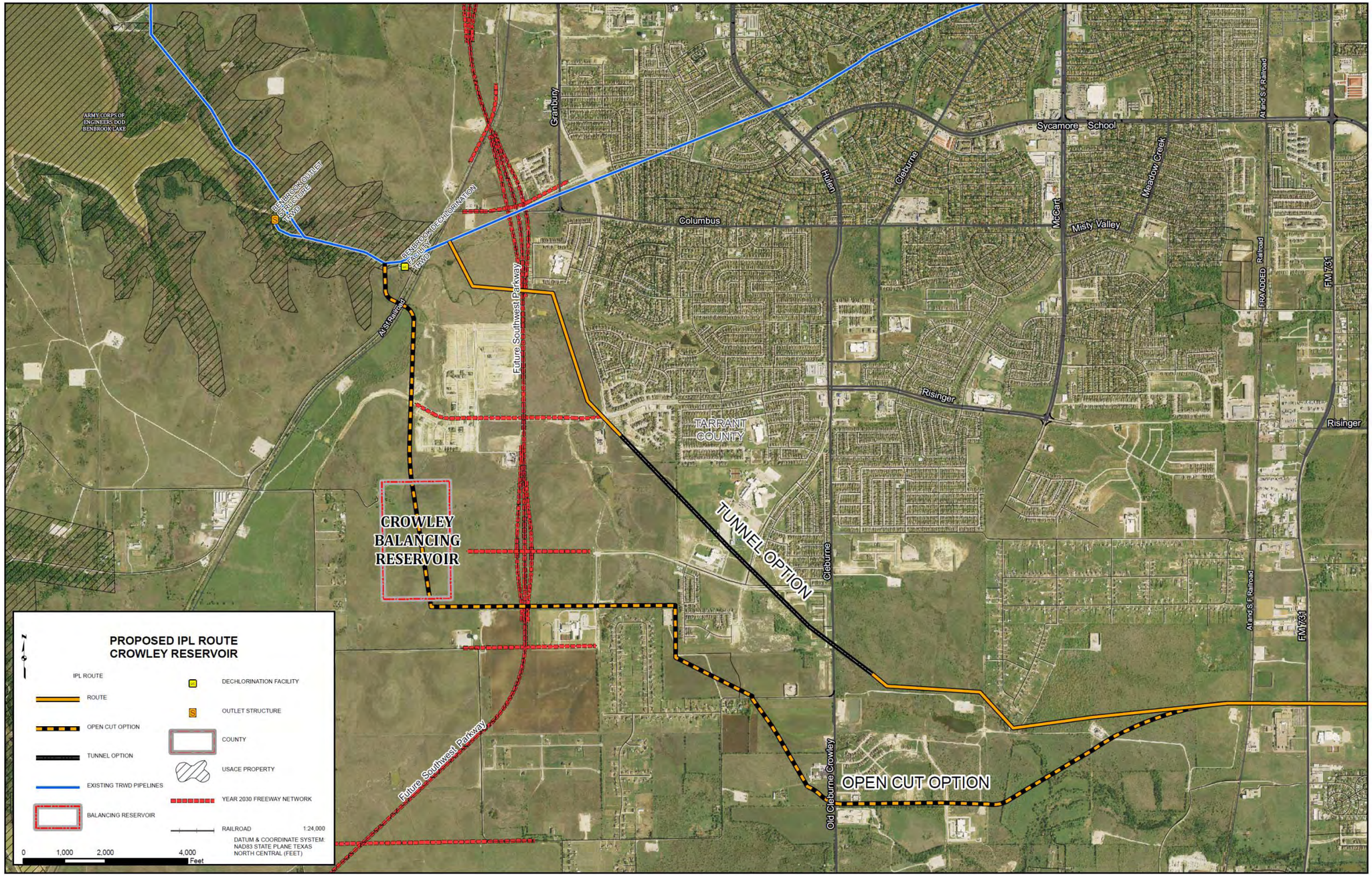

Figure 3-17. Crowley Terminal Storage Reservoir Location

Section 4
Hydraulic Evaluation

Prior hydraulic assessments have been presented in *Amendments 3 and 4 of Phase 1 of the Raw Water Transmission System Integration Study Report No. 2* and address peak capacity evaluations for multiple corridors of the proposed transmission pipeline. Since completion of Report No. 2, the corridors have been further refined into a selected corridor which includes a re-route from the corridor recommendations included in Report No. 2. Specifically, this revision impacts segments C and D using a new corridor 7B which changes the alignment to south of Bardwell Reservoir and Lake Waxahachie and takes advantage of a slightly lower peak elevation at the Midlothian high point. The corridor changes are discussed in greater detail in Section 2 of this report.

This Section 4 focuses on the proposed integrated pipeline revised hydraulic criteria and hydraulic performance including pipeline sizing and capacity/power requirements for the pumping stations based on the most recent corridor revisions. Specific corridors and pump station locations have been identified and facility sizing has been established for the revised corridor. This section also includes the basic decision matrix information (associated with hydraulic performance) for the revised corridor.

4.1 Hydraulic Design Criteria

The various hydraulic criteria to be used in establishing pipe sizing, pumping capacity, total dynamic heads and power requirements are detailed in the following sections. Most of the design criteria are unchanged from Report No. 2 and the reader is referred to that report for more detail. Any changes to those previously established criteria are identified and clarified herein. Criteria used in conducting the hydraulic analysis are summarized comprehensively within this section (whether established in Report No. 2 or No. 3).

4.1.1 Pipes

Design Flows

Development of demand allocation and subsequent flows by pipe segment has been established in previous reports. The CDM team has been directed to use the peak flows summarized in **Table 4-1** for purposes of sizing the integrated pipeline facilities. These flows represent peak, future hydraulic flow requirements by pipeline segment serving TRWD and Dallas. **Figure 4-1** illustrates all pipe segments of interest on the project.

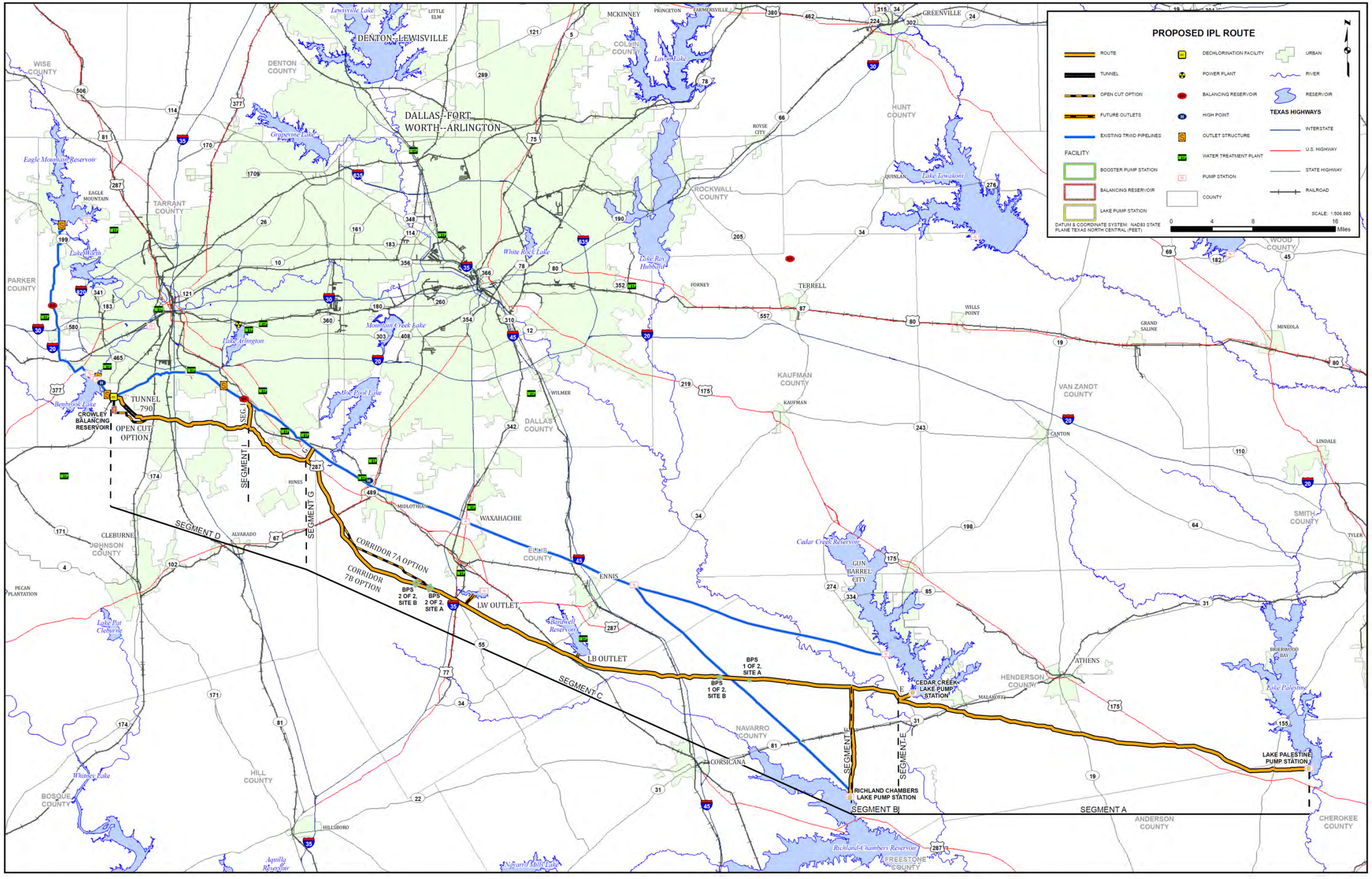

Figure 4-1 Integrated Pipeline Route Overview

Table 4-1. Design Flows by Pipe Segment

Segment	*TRWD Capacity*	*DWU Capacity*	*Total*
	(MGD)	*(MGD)*	*(MGD)*
A	0	150	150
B	127	150	277
C	197	150	347
D	197	0	197
E	127	0	127
F	70	0	70
G	197	150	347
H*	0	150	150
I	197	0	197

*- Peak Dallas flows delivered to a takeoff point at the upstream end of Joe Pool Lake for delivery to Dallas in an as-of-yet undetermined configuration

Friction Factors

Various hydraulic criteria and friction loss assumptions have been established for previous analyses of the Integrated Pipeline. Use of the Colebrook-White formula to predict friction factors is recommended for this phase of planning utilizing the Darcy-Weisbach formula with an absolute roughness value of 0.003 feet. As discussed in Report No. 2, this approach produces similar results to a Hazen Williams C coefficient of 120 (although slightly more conservative). This increased conservatism should be adequate to represent both minor and dynamic friction losses in the transmission piping system at this level of planning. During final design, this approach will be developed further into distinct analyses as recommended under the design standardization.

Pipe Sizing

Optimization of pipe sizing has been performed by comparing capital investment costs versus energy costs on a present worth/life cycle basis. The methodology and results are the subject of separate technical memoranda included in Appendix F and entitled:

- "Transmission Pipe Size Selection – Life Cycle Costs Analysis and Assumptions and Findings" dated July 20, 2009.
- "Infrastructure Sizing, Tunneling, and Pump Station Configuration Analyses – Findings and Conclusions" dated December 17, 2009.
- "Infrastructure Sizing, Tunneling, and Pump Station Configuration Analyses – Findings and Conclusions-Updated" dated February 24, 2010.

Although conclusions indicate that current pressure and velocity limitations and friction criteria are sound for planning level pipe sizing, comparisons between a selected size and one standard pipe size larger and one standard size smaller are comparable in terms of life cycle cost. The analysis is quite sensitive to the length of the life cycle period, demand impacts (and therefore pumping energy used) after 2030, material cost quotations for pipe manufacture and delivery, energy costing assumptions, and impacts of energy savings (vs. capital expenditure) for tunneling. Therefore, additional life cycle and related sensitivity analyses are planned during the

IPL conceptual design phase to optimize pipe size for each segment and facility selection by location. As a result, the final pipe and facility sizing is subject to change from those recommendations included herein.

Table 4-2 identifies the peak flow rates and corresponding pipe sizes used for the hydraulic analysis and form the basis for this analysis.

Table 4-2. Design Flows and Sizes by Pipe Segment

Segment	*Design Flow*	*Nominal Pipe Size*
	(MGD)	*(Inch)*
A	150	84
B	277	108
C	347	108
D	197	84
E	127	72
F	70	66
G	347	108
H	150	84
I	197	84

Maximum Velocity and Peak Operating Pressure

Analysis of velocity and pressure limitations for a variety of piping and pumping configurations for this project indicates that a hard and fast limitation within these categories is not necessary. For example, both steel and PCCP transmission pipe can be economically designed for higher operating pressures in the range of 250 psi and life cycle costing comparisons indicate that the higher pressure pipe (in conjunction with fewer pumping stations) is cost competitive with the alternative configurations. A general limitation of 250 to 275 psi peak operating pressure (primarily at the discharge side of pumping stations) has been applied for the 2 booster pump station configurations. These maximum operating pressures have been updated from those listed in Report No. 2.

Peak velocity for the pipe segments at the designated design flow varies from about 6 to 8.5 fps while the head loss (per thousand feet) varies from about 1 to 2.25. Note that the highest head loss does not necessarily correspond with the highest velocity as this relationship is dependent on pipe size and the ratio of wetted perimeter to cross-sectional area (See Table 4-6). It is reasonable to allow some flexibility in the velocity criteria as long as the head loss is maintained in a reasonable range, low enough that particulates in the raw water will not cause damage to the pipe linings at higher velocities.

Again, these considerations are subject to change and more in depth evaluation is planned segment by segment during the conceptual design phase.

4.1.2 Pump Station

Design Station Capacities

Table 4-3 identifies anticipated pumping station capacities required to meet the future demands of TRWD and Dallas. These flow rates will provide the basis for needed pumping station infrastructure along the transmission system.

Table 4-3. Proposed Maximum Pump Station Capacities

Pump Station	*Design Pumping Rate, (MGD)*
Intake Pump Stations	
• Lake Palestine	150
• Cedar Creek	127*
• Richland-Chambers	70*
Booster Stations	347

* Capacities under bypass mode may be higher than indicated.

Pump Curves and Variable Speed Application

The preliminary pump selections include vertical turbine pumps for all three lake intake structures and a horizontal split case type for all booster pumping stations. Vertical turbine "barrel" pumps are an option for consideration at the booster pumping stations (as discussed separately as part of the on-going design standardization effort by the IPL Conceptual Design Team).

As part of pumping equipment selection the following target efficiencies were assumed at the design flows.

- Pump efficiency of 85- 90 %
- Motor, efficiency of 95 %
- Variable frequency drive efficiency of 96 %

Although achieving an efficiency of 90 percent is feasible for these large pumps, efficiency of 85 percent will be more typical which may cover a range of pump manufacturers and operating points. An operating efficiency of 95 percent is typical for premium efficiency motors operating under full load conditions. An efficiency of 96 percent is typical for variable frequency drives when operating under full load conditions.

The range of TDH requirements for the chosen pipe size and corridors are given in the **Table 4-4**. The flows and estimated pumping head have been updated from those listed in Report No. 2.

Table 4-4. Total Dynamic Head Requirements

Pump Station	*Design Pumping Rate, (MGD)*	*Total Dynamic Head (ft)*
Intake Pump Stations • Lake Palestine	150	210-625
• Cedar Creek	127 (190)[1]	136-378 (323-596)[1]
• Richland-Chambers	70 (190)[1]	143-396 (326-602)[1]
Booster Stations (2 booster) • Booster No. 1	347 (100)[1]	263-577
• Booster No. 2	347 (190)[1]	152-582

1. Assumes maximum bypass condition with a combination of pumping from Cedar Creek and Richland Chambers and main line pressures limited to approximately 250 psi.

Preliminary screening of vertical and horizontal pump applications for both the intake and booster pumps indicates that a number of offerings are available from several vendors that can meet the high head requirements with as few as 6 to 8 duty pumps (booster stations). It is anticipated that variable speed pumping will be an operational necessity to meet the full range of flows and heads while limiting the number of pump settings in each station. These pump offerings have been screened in greater detail and represent updated information since publication of Report No. 2. More information is included in the separate, on-going design standardization task deliverables from the IPL Conceptual Design Team.

Pump selection will be further refined with recommended selections for the final pipeline alignment as part of the conceptual design phase.

4.1.3 Operational Storage

Balancing reservoirs are possible at a number of locations including the highest point on segment D. This particular location for a balancing reservoir (Crowley) would enable gravity flow to the TRWD West Fork System, including Benbrook Outlet Structure, Clear Fork Outlet Structure, Benbrook Water Authority, Weatherford PS, Benbrook BPS, Rolling Hills WTP, and the Kennedale Balancing Reservoir. A decision to tunnel through the Benbrook highpoint may preclude this location for a balancing reservoir and life cycle costing appears to favor the tunneling option under some scenarios (to be refined further during conceptual design). TRWD operational experience indicates a desired storage volume of approximately 200 MG, which translates to about 24 hours supply under peak operating conditions. Doubling this storage volume in future phases (if sufficient land is available) could double emergency storage to 48 hours or more under moderate to peak delivery conditions. This criterion is acceptable for application to sizing any of the proposed balancing reservoirs in the new transmission system unless there are special circumstances to consider. Some special circumstances for increasing storage could include considerations for emergency supply in the event of an extended system outage or emergency repair and providing additional redundancy for other balancing reservoirs in the system (such as Kennedale).

For suction supply to booster pumping stations, TRWD experience has shown that 4 to 6 hours of operating storage at peak operating capacity is sufficient and provides enough reaction time for starting and stopping pump operation if warranted. Again, more storage may be appropriate if there are special circumstances. For the largest capacity booster pumping station of 347 MGD, suction storage would need to be sized between 60 and 87 MG which could be constructed in two or more phases (interim and future) to enhance operations and maximize deferral of capital investment.

Terminal storage at the delivery points to participants has not been addressed within the scope of this section and is subject to participant-specific operating rules and requirements as appropriate.

4.1.4 Reservoir Ranges/System Operating Rules

For peak flow pipe sizes, the operating levels in the supply reservoirs are summarized in **Table 4-5**. There are no real-time operating rules for pump station operation in the steady state model. For purposes of estimating maximum intake pump station hydraulic power requirements, the "minimum conservation pool" elevations were used. Since the reservoir operating ranges mostly affect pump selection rather than the hydraulic performance, maximum conservation pool was not used for this phase of analysis except to estimate ranges of required pumping head.

Table 4-5. Reservoir Ranges

Reservoir	*Minimum Conservation Pool Elevation, ft*	*Maximum Conservation Pool Elevation, ft*
Lake Palestine	310	345
Cedar Creek	282	322
Richland-Chambers	273	315
Benbrook Lake	682	694

4.2 Hydraulic Analysis

Similar to the methodology used for Report No. 2, hydraulic evaluations in this report were all conducted using MS Excel spreadsheet tools with appropriate updates to reflect modifications for the selected corridor. Specific analyses associated with flow diversions through the G and H segments (for Bachman delivery) were not performed for this updated report as these were not considered sufficiently different from the results presented in Report No. 2 and infrastructure sizing memoranda to justify additional simulation. Joint, full capacity diversions for both TRWD and Dallas through Segment G (347 mgd) requires meeting a minimum HGL elevation of 789 msl as shown in the HGL figures in this section. A split flow diversion (some flow to Benbrook and some through Segment G) requires dissipating excess head somewhere within the G segment. Although this excess head could, potentially, be recovered with hydro turbines, preliminary life cycle analysis of the excess energy utilized during these events (see Appendix H) indicates that high flow split diversions will occur infrequently and may not justify installation of energy recovery facilities.

Segment I has been sized for 84 inch and, based on the current route, a maximum HGL elevation of 773 feet at the IPL turnout has been estimated based on meeting a future maximum control elevation of 742 feet at the Kennedale Balancing Reservoir.

Hydraulic evaluation for this report focused on delivery from Lake Palestine to the Lake Benbrook area within the recommended pipeline route (see Section 2) and a range of flow conditions. As described in Section 1, a workshop meeting was held on March 16, 2010 to select the number of booster pump stations, recommend the lowest life-cycle cost pipe size, and decide if deep tunnels would be constructed through Midlothian and/or the Crowley portions of the pipeline. It was recommended during that meeting that this hydraulic analysis be completed using only the two booster pump station configuration and assuming construction of a tunnel at elevation 790’ through the Benbrook high point.

General configuration assumptions used in developing the updated hydraulic analyses include the following:

- Corridors A1 and F2 were used, consistent with the analysis in Report No. 2
- The main line corridor consists of segments A1, B, C (corridor 7B and Corridor 6), D6 as generally depicted in Report No. 2 (but representing the latest pipeline routing for Corridor 7B) and minor updates for the other main corridor segments.
- As presented in Report No. 2, intake pumping stations are represented at Lake Palestine, Richland Chambers Reservoir, and Cedar Creek Reservoir.

Figures 4-2 through **4-5** illustrate all the modeled segments A through F in detail.

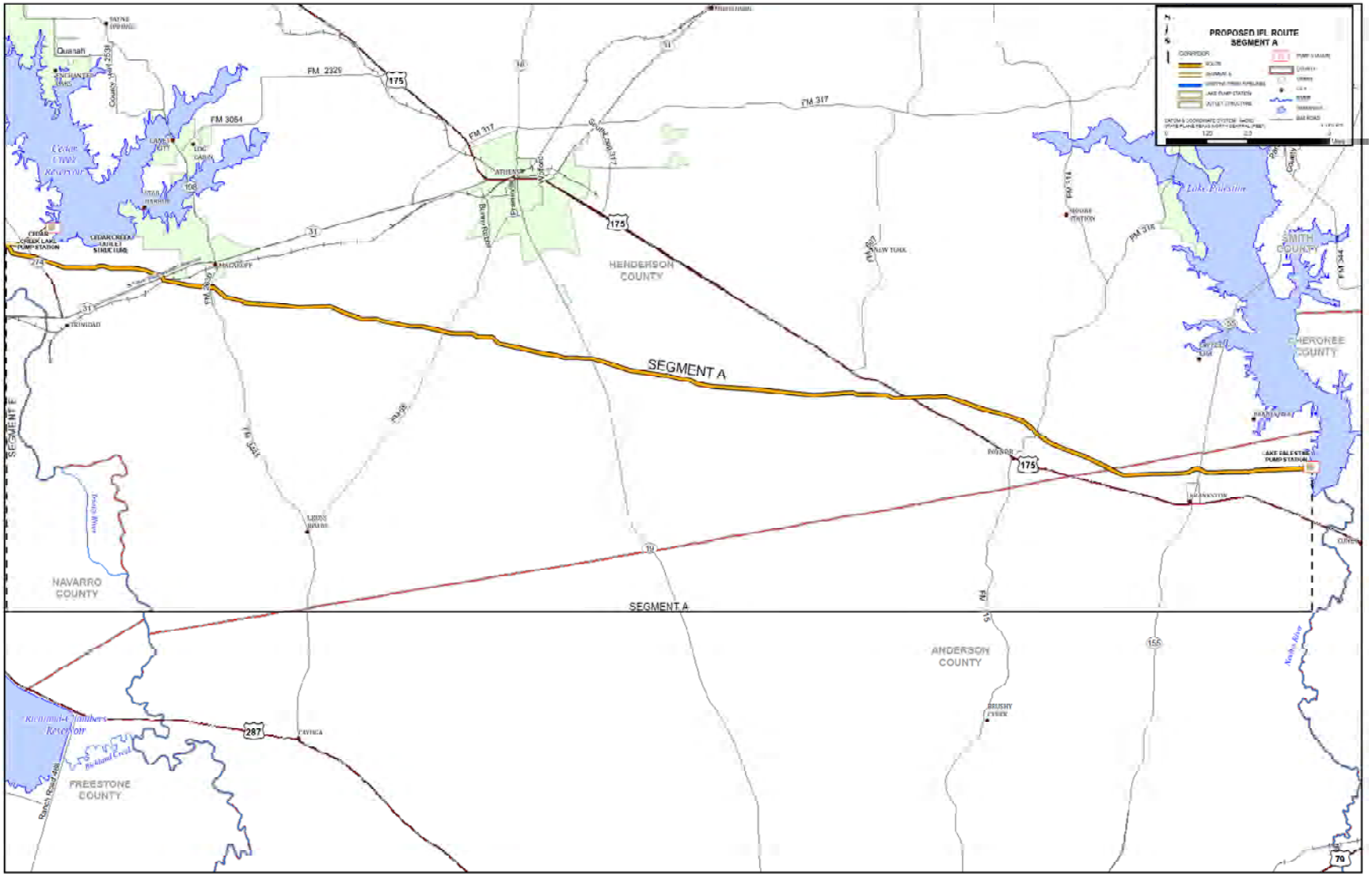

Figure 4-2. Segment A

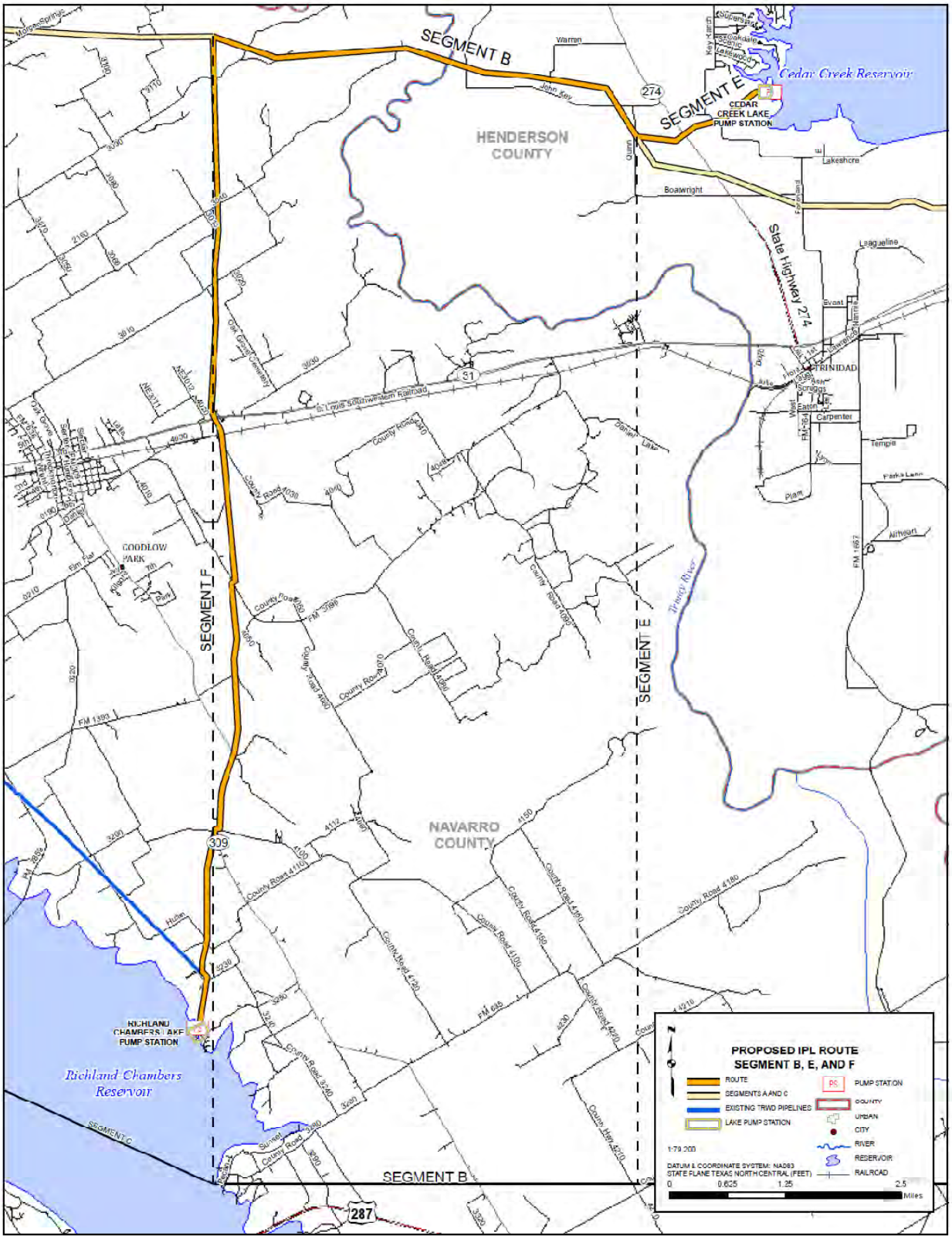

Figure 4-3. Segments B, E, and F

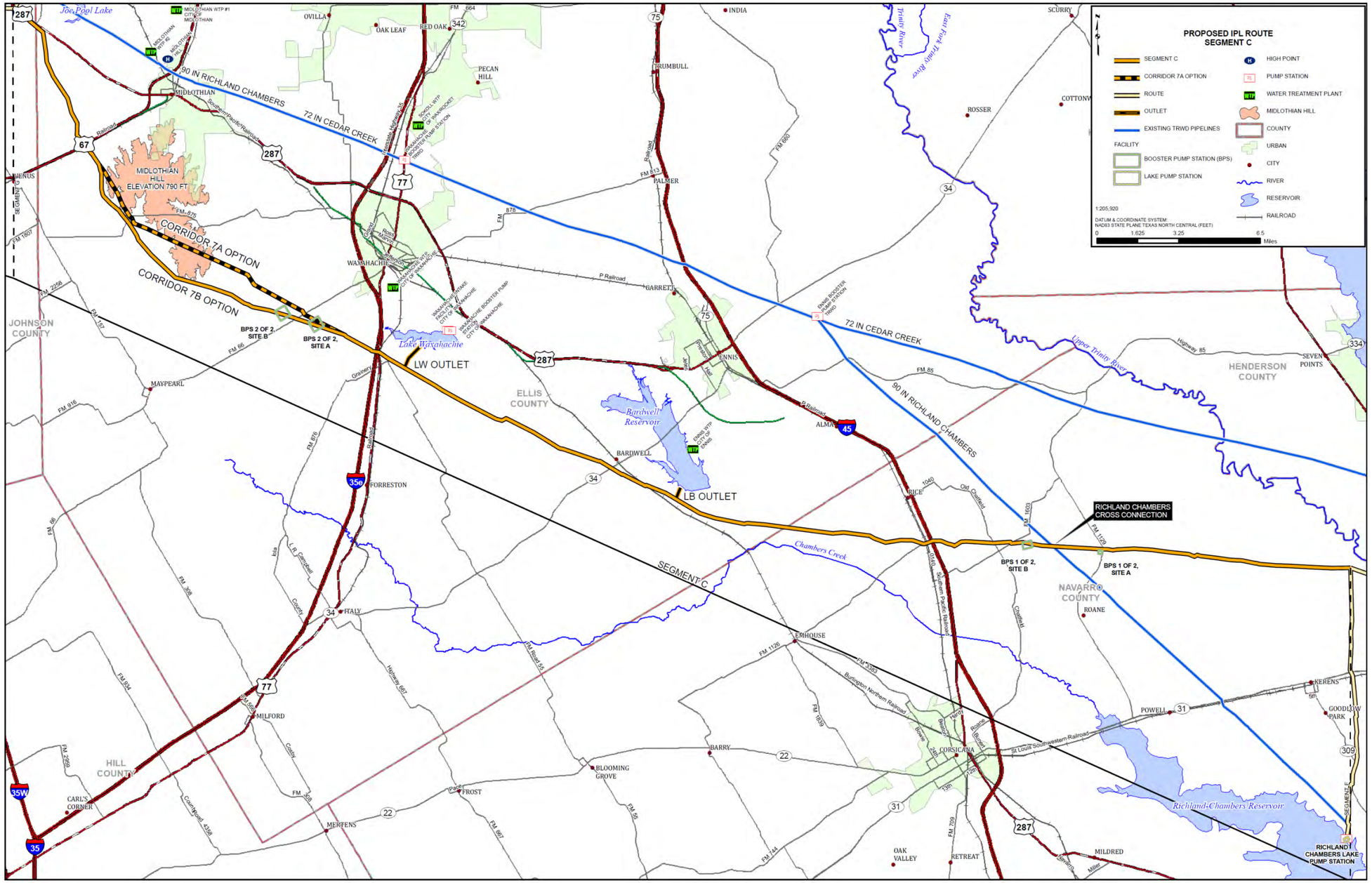

Figure 4-4. Segment C

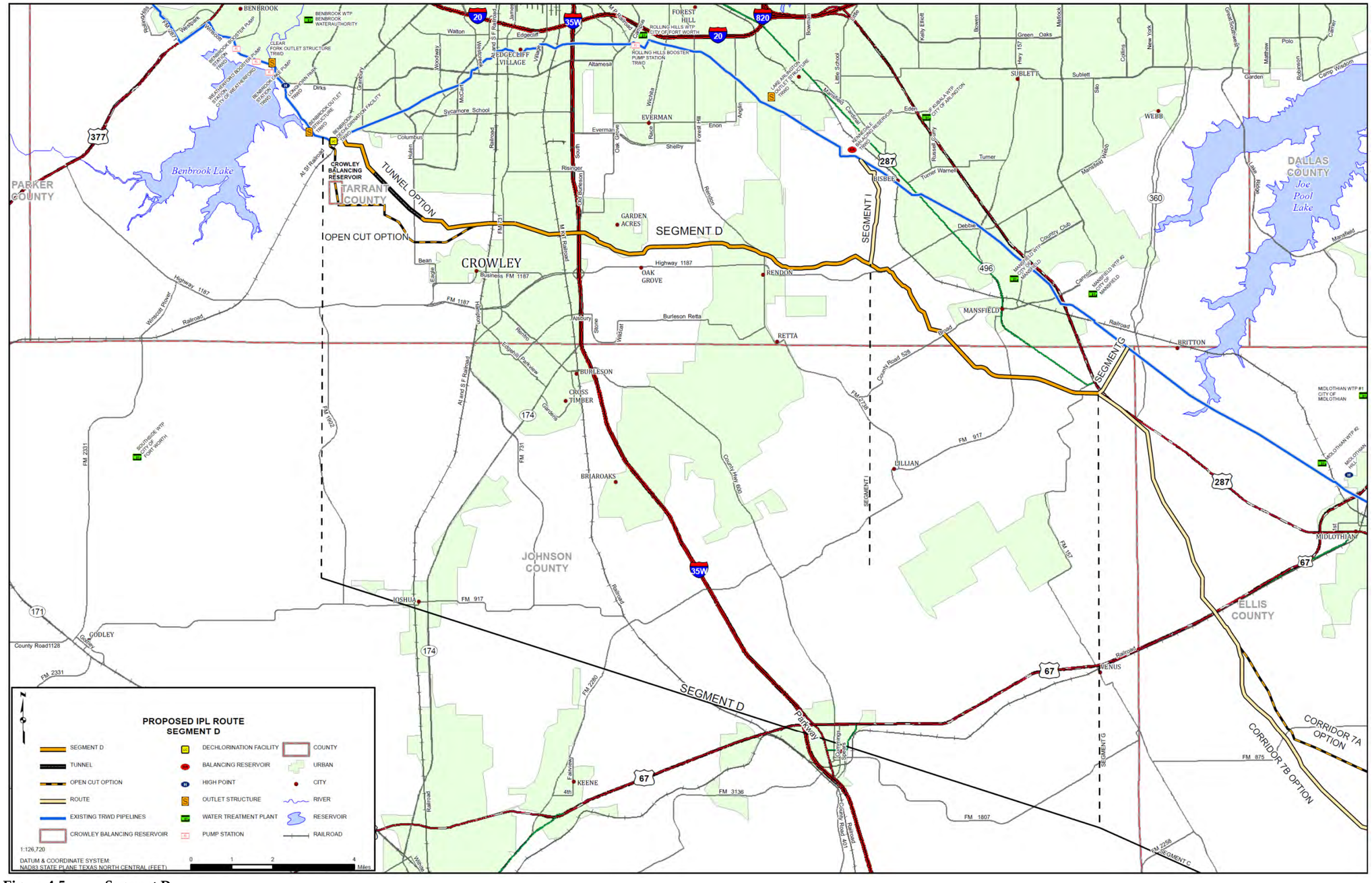

Figure 4-5. Segment D

4.2.1 Revised Corridor Results

Main Transmission Pipeline

Figures 4-6 through **4-10** depict the hydraulic grade line (HGL) performance plots for the 2-booster pump station configuration for the final pipeline corridor selected in Report No. 2 and as subsequently modified to incorporate the Corridor 7b (within Segment C) re-route.

Generally, the 2-booster pump station alternative required pumping to about 250 psi. **Figure 4-6** shows peak, future flow conditions (blue HGL) as well as 3 configurations of bypass (see later discussion) while pumping to a future balancing reservoir (Crowley) at the Benbrook high point. Two alternate sites for Booster Station No. 1 are under consideration and were modeled for hydraulic performance but only the currently preferred, alternative 1 site (western most), is presented here. For the chosen pipe sizes, the alternative 1 site helps to maintain the operating pressure on the discharge side of Booster Station No. 1 at or below 250 psi, but will potentially require portions of Segment A nearest to the Lake Palestine pump station to maintain operating pressures slightly above this limit under peak flow conditions. The situation reverses itself if the alternative 2 (eastern) site is used.

Figure 4-7 depicts the peak, future flow conditions while pumping to the 790 msl outfall elevation on the western side of the Benbrook high point (i.e. configuration with a deep tunnel through Crowley). Note that the alignment for this configuration is different from the open-cut construction with a Crowley balancing reservoir option as shown in Figure 4-5. This revised alignment slightly shortens the overall length and the highpoint above the tunnel is slightly lower in elevation, but the hydraulic performance of this alternative is not significantly affected (hence the ground profile in Figure 4-7 is the same as in Figure 4-6 to better depict the visual difference in pumping head for Booster Station No. 2).

This alternative assumes that a tunnel would be constructed through the Benbrook high point so that the HGL can be lowered under all pumping conditions to the Lake Benbrook area. This represents a lowering of approximately 80 feet of static pumping head from booster pump station No. 2 under all operating conditions that pump west towards Benbrook. However, gravity delivery to the Rolling Hills WTP from a balancing reservoir located at the high point would be precluded under this scenario. Further evaluation of the pros and cons of these alternatives will be needed during conceptual design (see "Next Steps" at the end of this section).

Representative HGL plots for corridors E and F2 under peak delivery (non-bypass) conditions are shown in **Figures 4-8 and 4-9.** Refer to **Table 4-6** for required Richland Chambers and Cedar Creek Intake pumping heads for full capacity pumping.

Bypass Operations

A separate analysis was conducted to evaluate flow transmission in pump station bypass mode. Two cases were evaluated and the primary criterion for evaluating each case was to limit main transmission pipeline operating pressures to approximately 250 psi (even if higher horsepower pumps are required at any given station to accommodate the flow and head under a bypass vs. non-bypass scenario). For case 1, pump station bypass analysis was based on trying to maximize flow from Lake Palestine to Lake Benbrook without additional flow injections along the way. For Case 2, a combination of pumping is used from Cedar Creek and Richland-Chambers to maximize bypass of one of the booster stations (a more commonly anticipated bypass theme). The results for the bypass analyses are also included in **Figure 4-6**.

Hydraulic Profile for Corridor-7B, 2 BPS, Base Pipe Sizes

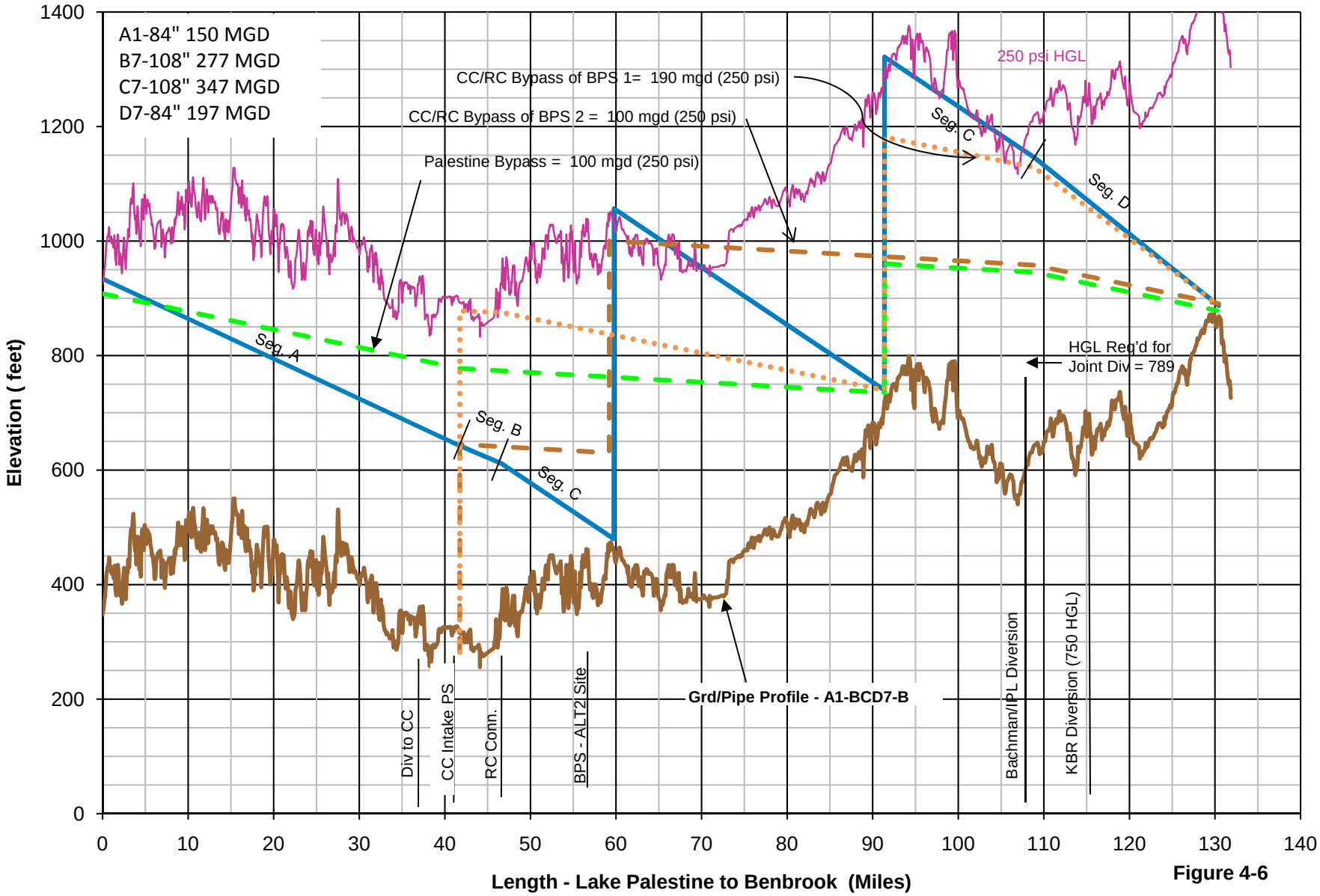

Figure 4-6

Hydraulic Profile for Corridor-7B, 2 BPS, 790 Tunnel, Base Pipe Sizes

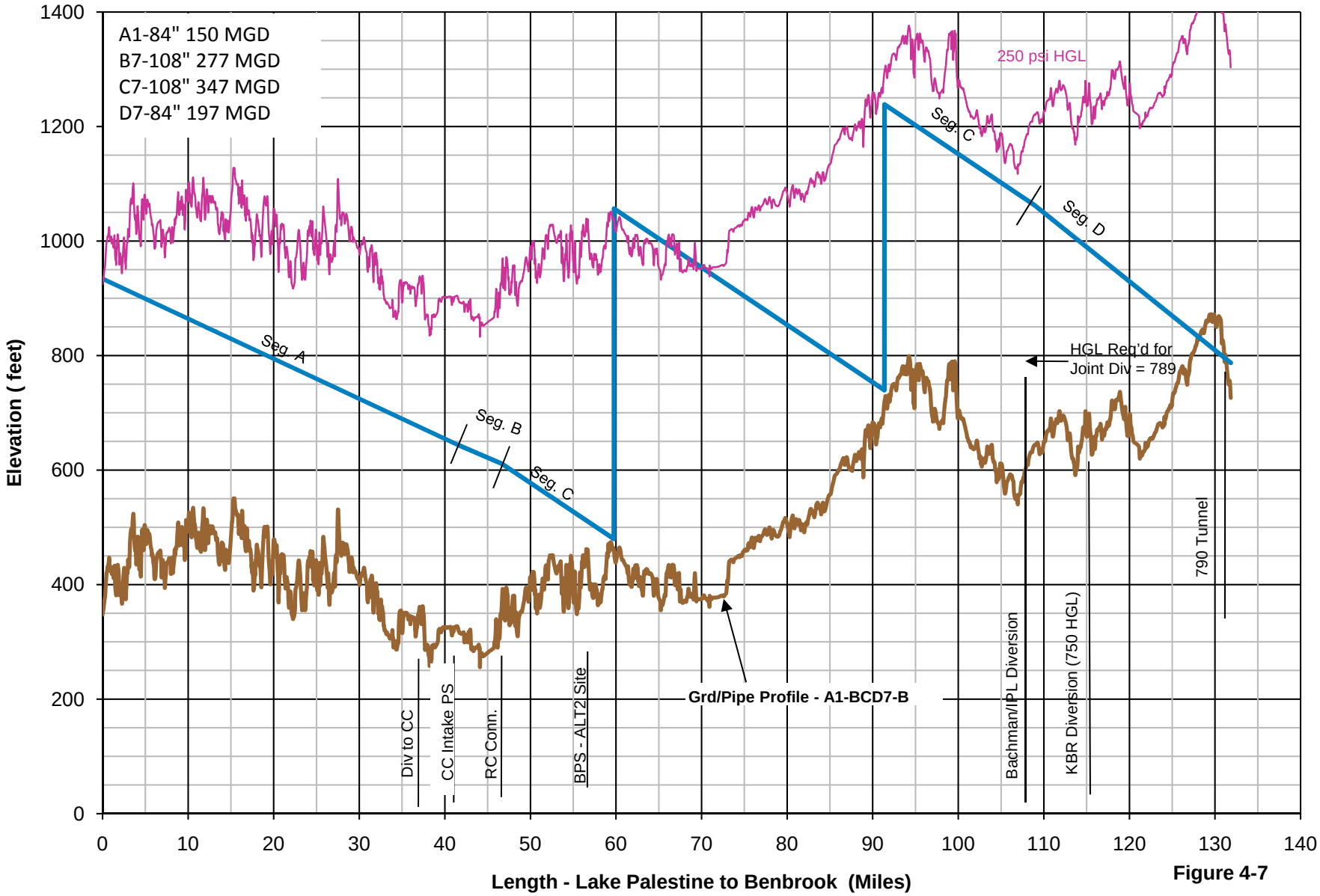

Figure 4-7

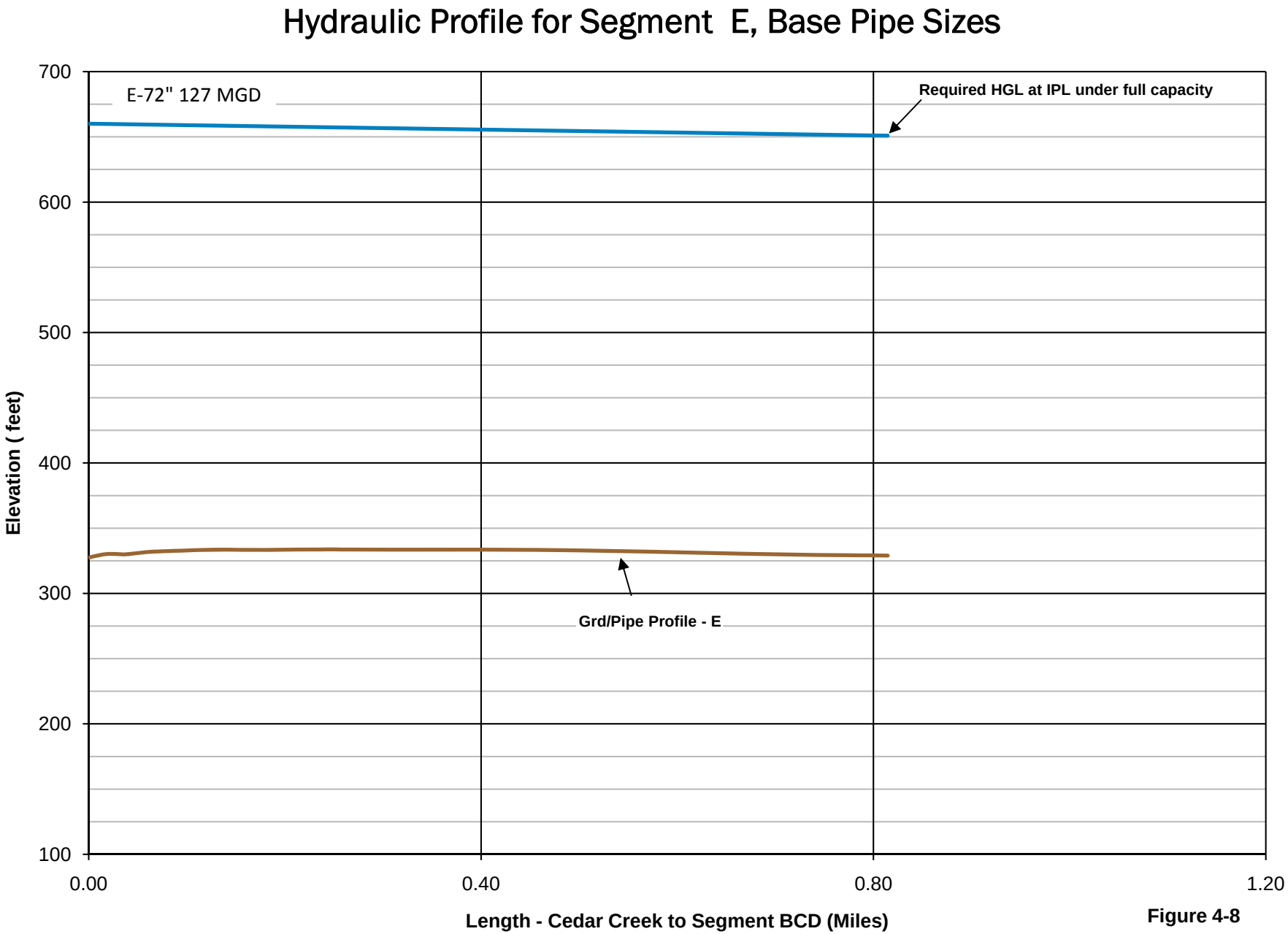
Hydraulic Profile for Segment E, Base Pipe Sizes
E-72" 127 MGD
Required HGL at IPL under full capacity
Grd/Pipe Profile - E
Elevation (feet)
700
600
500
400
300
200
100
0.00
0.40
0.80
1.20
Length - Cedar Creek to Segment BCD (Miles)

Figure 4-8

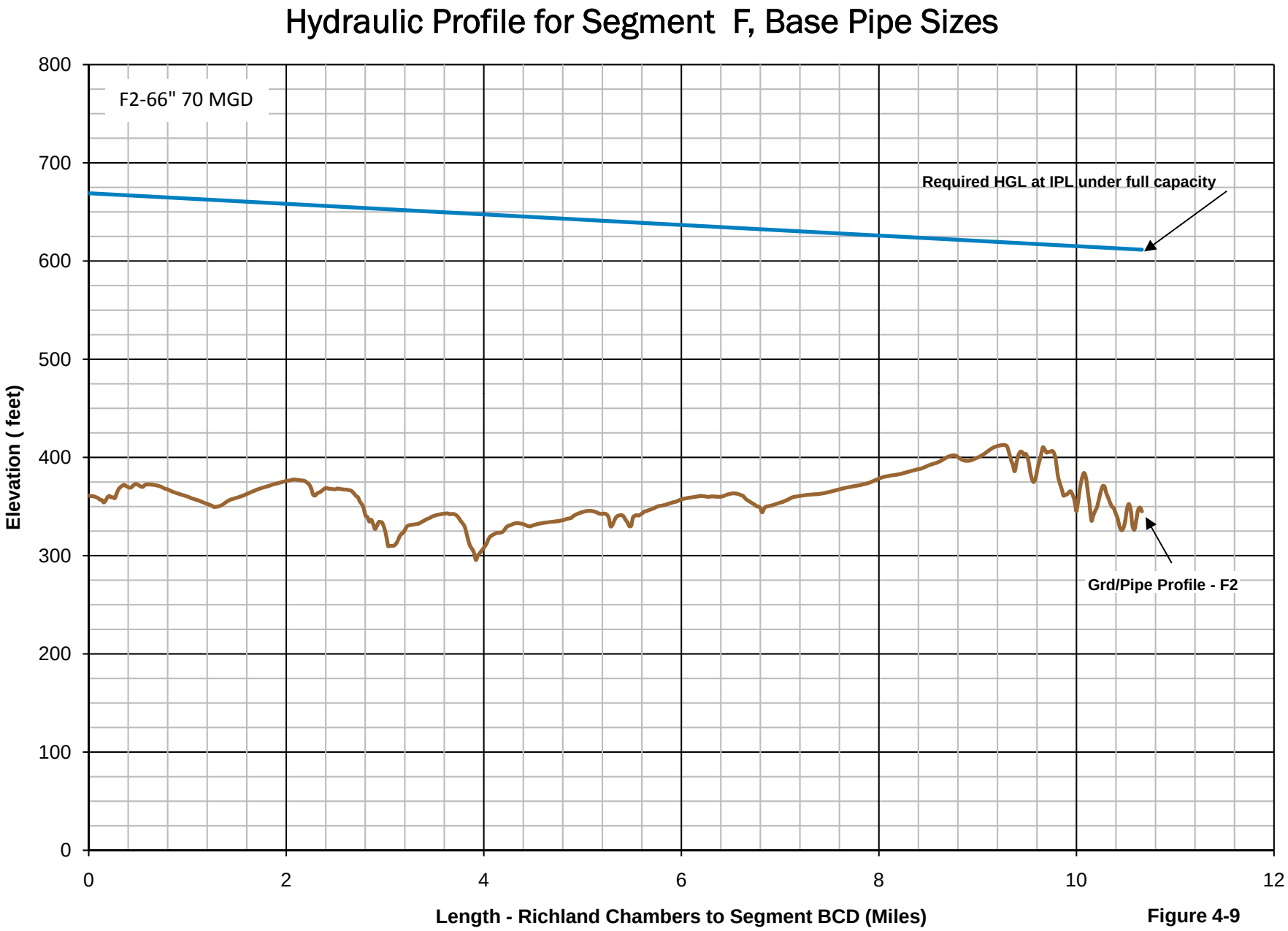
Hydraulic Profile for Segment F, Base Pipe Sizes
F2-66" 70 MGD
Required HGL at IPL under full capacity
Grd/Pipe Profile - F2
Elevation (feet)
800
700
600
500
400
300
200
100
0
0
2
4
6
8
10
12
Length - Richland Chambers to Segment BCD (Miles)

Figure 4-9

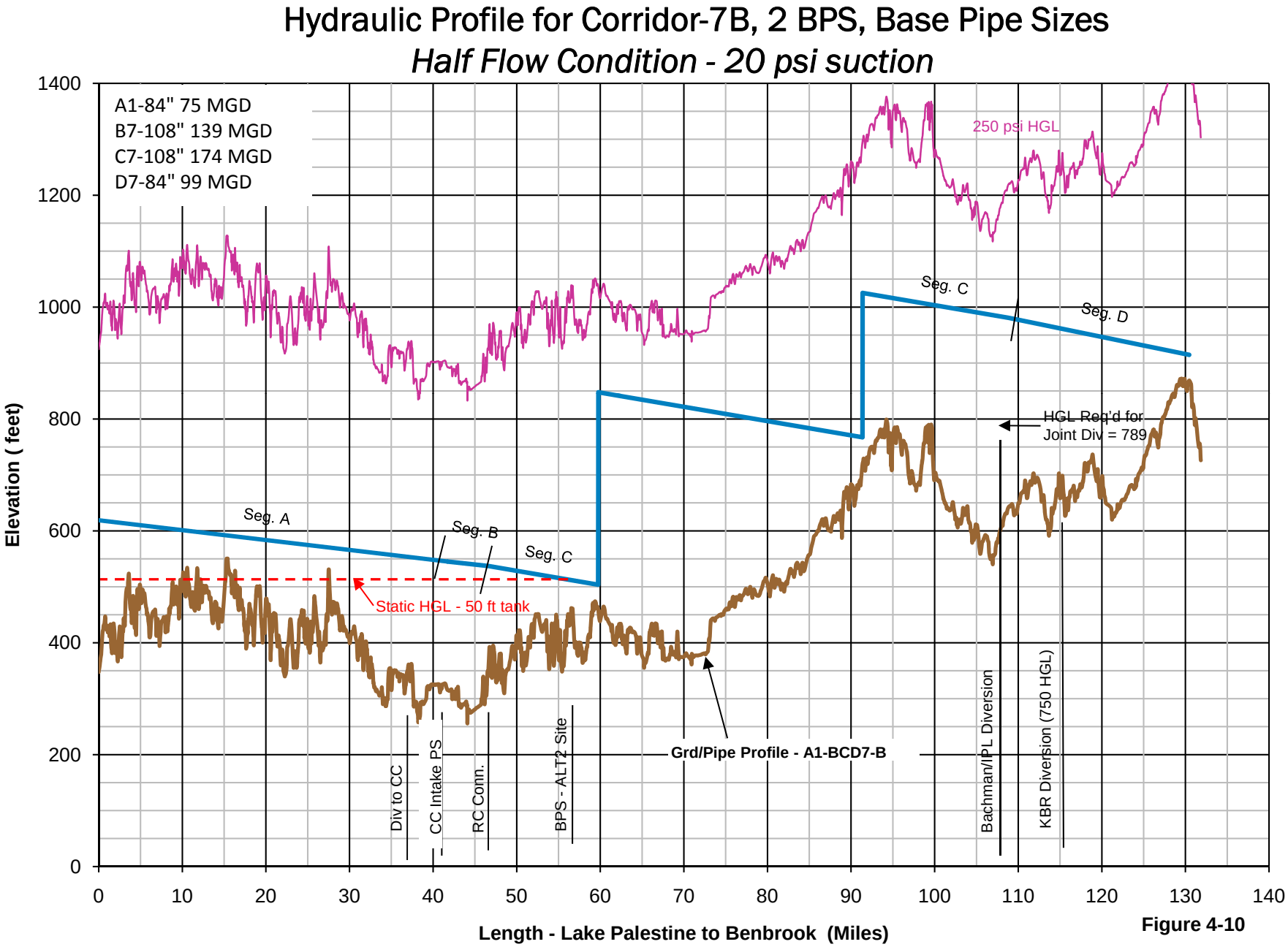
Hydraulic Profile for Corridor-7B, 2 BPS, Base Pipe Sizes
Half Flow Condition - 20 psi suction
A1-84" 75 MGD
B7-108" 139 MGD
C7-108" 174 MGD
D7-84" 99 MGD
250 psi HGL
Seg. A
Seg. B
Seg. C
Seg. C
Seg. D
HGL Req'd for Joint Div = 789
Static HGL - 50 ft tank
Grd/Pipe Profile - A1-BCD7-B
Div to CC
CC Intake PS
RC Conn.
BPS - ALT2 Site
Bachman/IPL Diversion
KBR Diversion (750 HGL)
Elevation (feet)
Length - Lake Palestine to Benbrook (Miles)
0
200
400
600
800
1000
1200
1400
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140

Figure 4-10

Table 4-6. Hydraulic Results with Corridor 7B Reroute

Scenario	Segment	Flow (mgd)	Pipe Size (in)	Velocity (fps)	Head loss (ft/1000 ft)	Pump Station	TDH (ft)	TDH (psi)	Hydraulic Power (HP)
2 BPS - To Benbrook	A1	150	84	6.03	1.29	Pal Intake	624	270	16,428
	B7	277	108	6.74	1.17				
	C7	347	108	8.44	1.84	BPS1	577	250	35,141
		347				BPS2	582	252	35,446
	D6	197	84	7.92	2.23				
	E	127	72	6.95	2.12	CC Intake	378	164	8,426
	F2	70	66	4.56	1.00	RC Intake	396	172	4,865
									100,306
2 BPS - To Benbrook (790 Crowley Tunnel)	A1	150	84	6.03	1.29	Pal Intake	624	270	16,428
	B7	277	108	6.74	1.17				
	C7	347	108	8.44	1.84	BPS1	577	250	35,141
		347				BPS2	499	216	30,391
	D6	197	84	7.92	2.23				
	E	127	72	6.95	2.12	CC Intake	378	164	8,426
	F2	70	66	4.56	1.00	RC Intake	396	172	4,865
									95,251
2 BPS - To Benbrook (1/2 flow)	A1	75	84	3.01	0.32	Pal Intake	309	134	4,068
	B7	138.5	108	3.37	0.29				
	C7	173.5	108	4.22	0.46	BPS1	344	149	10,475
		173.5				BPS2	258	112	7,857
	D6	98.5	84	3.96	0.56				
	E	63.5	72	3.47	0.53	CC Intake	268	116	2,987
	F2	35	66	2.28	0.25	RC Intake	279	121	1,714
									27,100

For case 1, bypass analysis (conveying Lake Palestine water with one booster pump station bypassed) indicates capacity is limited to about 100 mgd. For case 2, either booster station can be bypassed (alternated), although bypass of booster 1 while maintaining operation at booster 2 can achieve greater bypass capacity while keeping the main transmission line operating pressures at or below about 250 psi. This second case requires utilizing the Cedar Creek and/or Richland-Chambers intake pump stations under high head conditions and could result in operating pressures in the E or F segments exceeding 250 psi (proper pipe sizing and optimization of associated flow contributions from each supply reservoir are critical to controlling these branch pressures). To take full advantage of a given bypass configuration, it would be necessary to operate at higher suction pressures at the bypassed station and, as a result, portions of the main transmission pipeline would have to be designed for higher operating pressures.

For case 1, bypass flows are limited to about 100 mgd and Booster Station No.1 is bypassed while Booster Station No. 2 is maintained in operation. For case 2, flows are contributed from both Cedar Creek and Richland-Chambers (no contributory flows from Lake Palestine for this scenario). If Booster Station No. 1 is utilized and Booster Station No. 2 bypassed, flows are limited to about 100 mgd. Since both Cedar Creek and Richland-Chambers lake pumping stations are used to boost up the operating HGL, there is not a significant additional gain in head achieved with the first booster station operating and the second booster station off line, limiting the capacity of this configuration. However, if both of the intake stations are used to boost the HGLs up to the 250 psi limit and the first booster station is bypassed instead, the second booster station can operate much as a true booster pumping application and nearly doubles the delivery capacity over the alternate case 2 configuration (approximately 190 mgd).

Low Flow Pumping Considerations

Figure 4-10 depicts the operating HGL under half flow conditions (with the configuration discharging to a balancing reservoir at Crowley). Each supply reservoir is delivering half the flow shown in Figures 4-6 and 4-7. The represented flow condition approximately represents a transition point from multiple booster pumping operation to bypass and single booster operation (generally the same flow delivered to the Benbrook area for case 1 bypass, but considerably less than case 2 bypass with Booster Station No. 1 out of service).

Under lower flow rates from Lake Palestine (below 75 mgd), there may be need for a balancing reservoir near the highpoint in Segment A to maintain the HGL above the ground surface while conserving head at Booster Station No. 1. Alternatively, the balancing reservoir could serve also as the suction supply to Booster Station No. 1 (remote forebay) to avoid this concern. However, the same reservoir would need to be bypassed under high flow conditions out of Lake Palestine (defeating this advantage). The overall need/benefit for this reservoir may depend mostly on the anticipated mode of operations. Current operations planning indicate that withdrawals from Lake Palestine are rarely anticipated to drop below 75 mgd or the system will go into bypass mode at these lower flows. Therefore, at this time there appears to be little justification for a balancing reservoir near the highpoint in Segment A (approximately 550 ft msl).

Another potential concern is draining of raw water supply from the highpoints along segment A into the suction supply tank or reservoir at Booster Station No. 1 after routine shut down of the Segment A pipeline and Lake Palestine Intake pump station. The line would only drain for those portions of the Segment A line installed at a higher elevation than the overflow of the booster

station supply tank (limited volume). There are several ways to solve this problem for either Booster Station site. Options include an automated valve to isolate the line ahead of the supply tank/reservoir, installation of a stand pipe with sufficient height (and isolation from the supply tank/reservoir), construction of a tank or reservoir with sufficient volume to receive the excess volume in the Segment A pipeline (easier to accommodate with a reservoir). Operational issues can be further explored during conceptual design, but should not present an issue for selection of either site for Booster Station No. 1.

Table 4-6 shows hydraulic power (no pump or electrical efficiency losses included) used for the half flow condition along with that for the full capacity conditions (with and without the tunnel under Benbrook highpoint).

4.3 Hydraulic Evaluation Criteria Matrix

In order to provide a comprehensive and consistent basis for comparing corridor alternatives for hydraulic performance, evaluation criteria were developed as shown in **Table 4-7**. For consistency, the scoring for corridors 1 and 5 (hybrid of both recommended in Report No. 2) is compared with corridor 7. Each evaluation criteria is designated either quantitative or qualitative. Quantitative criteria are scored on a number and qualitative criteria are scored on a scale of 'poor-fair-good-better-best'. The results in the table are generally based on evaluation under peak flows conditions.

4.4 Hydraulic Performance Summary

Updated findings and observations are summarized within specific categories below:

- The updated IPL configuration for corridor 7 is not substantially different in hydraulic performance from the previous corridor 1-5 performance. Net head requirements are generally equal when comparing the two corridors. Construction of a tunnel under the Benbrook high point (Crowley tunnel), would result in an average static head pump savings of 80 feet under virtually all delivery scenarios to the Lake Benbrook area. However, additional pumping to the Benbrook booster and for delivery to Rolling Hills water treatment plant may be necessary with this configuration. If, ultimately, the tunnel configurations at Crowley and Midlothian prove to be preferable, the corridor alignment should be altered somewhat to take full advantage of shortened length and lowered highpoints (See Section 2 for more discussion).
- Many bypass operating scenarios are possible and these have been examined further than in previous studies. While full bypass based on delivery of Lake Palestine (only) is limited to about 100 mgd, bypass pumping from Cedar Creek or Richland Chambers Reservoirs (or a combination) can take advantage of the ability to bypass either booster station. However, bypass of Booster Station No.1 and operation of Booster Station No. 2 has higher delivery potential (up to 190 mgd) over the alternate booster bypass configuration. Higher operating heads than under full capacity system delivery with both booster stations operating would be necessary from the intake pumping stations to take full advantage of this; portions of the intake delivery piping (segments E and F) as well as the main line IPL would have to be of higher pressure class as well.

Table 4-7. Hydraulic Evaluation Criteria Matrix - Main Corridors

Evaluation Criteria	Unit	2 Booster Stations		
		1	5	7
Hydraulics				
Minimize overall pumping (Peak Flow)	HP	100,879	98,030	100,306
Minimize RC and CC Pumping (Peak Flow)	HP	11,093	13,686	13,291
Diversion to Bachman w/o supplemental pumping	Yes/No	Yes	Yes	Yes
Ease of Operations	---	Best	Better	Good
Number of redundant power supply sources	#	2	2	2
Risk of total system shutdown	---	Best	Better	Better
Bypass capabilities (A through D)	Flow (mgd)	110	110	100
Delivery to Customers	---	Poor	Better	Fair
Maximize Storage (Bal R)	---	Good	Good	Good
Surge	---	Fair	Fair	Fair

- Preliminary pump selection screening has been completed for the booster pump stations as part of the design standardization process (being conducted by the IPL Conceptual Design Team) which indicates that high efficiency, high capacity/head units are available from multiple manufacturers. Preliminary evaluation also shows that these selections can be optimized to provide some additional run out while maintaining high mechanical efficiencies under potential variable (reduced) speed operations. Additional evaluation under numerous potential operating scenarios will be necessary during conceptual and final design phases to optimize final pump selection and configuration.

4.5 Next Steps

The tasks listed below will expand the hydraulic analysis during the Conceptual Design phase of the project. Much of the optimization modeling during this phase will be conducted using a fully integrated hydraulic network model which can take advantage of connectivity and simulation of the IPL with the existing transmission system.

- Develop hydraulic design basis for pipelines, appurtenances, outlet structures, connections, and terminal storage reservoirs. Also assess the impact of pipeline aging on loss of capacity.
- Use hydraulic and life-cycle cost analysis to further refine selection of lowest cost pipeline size for each segment of the IPL.

- Use hydraulic and life-cycle cost analysis to further refine selection of preferred pump station configuration (number of booster pump stations). Consider 2 or 3 booster pump station options.
- Further development of primary high capacity and bypass pumping potential for a range of pumping configurations and facility optimizations. Comparisons will be performed for bypass pumping associated with open cut pipeline vs. tunnels at Midlothian and Crowley with further life-cycle cost comparisons.
- Compare pumping from the Lake Benbrook area to the east towards the City of Ennis for open-cut and tunnel options at Midlothian and Crowley in terms of feasibility and flow volumes.
- Further refinement of hydraulic terminations at Longhorn Park to better characterize the recommended configuration including delivery to the Benbrook booster versus termination at the TRWD dechlorination facility.
- Hydraulic support analysis for evaluation of infrastructure phasing plans to ensure adequate delivery while optimizing deferment and capital investment of the IPL over time.
- Evaluate hydraulic delivery of flows from East Texas to Kennedale Balancing Reservoir (through Segment I) without delivery to Benbrook Lake through the IPL.
- Calculate the pressure and flow potential at interconnects to the existing TRWD system at the crossing of the Richland Chambers pipeline (TRWD segment 5) and the intersection of segment G.

Section 5
Costs

This section describes the project cost analysis and the current basis for the conceptual level opinion of probable capital cost and life cycle cost for the Integrated Pipeline route selection phase. Additional cost estimates will be generated and updated at project milestones such as conceptual, preliminary, and final design, each with greater detail so that estimates improve as project definition improves.

This section first describes parameters used in the cost analysis and its methodology. Next, capital cost estimates are summarized for each segment of the pipeline route and for each facility, followed by a life-cycle cost estimate of the recommended route. Detailed cost spreadsheets are included in Appendix F of this report.

The detailed cost spreadsheets and tables noted in this report have been validated by the 0% Value Engineering (VE) team. Most of the recommendations and cost estimating methodology suggestions were adopted and incorporated into this final report subsequent to the VE workshops held during the week of May 17, 2010. However, because some analyses were completed prior to the VE, many comparative cost estimates rely on older methodology. This is most evident in the appendices, which contain results from analyses completed prior to the VE. The costs in those sections will therefore not match the results in the main body of the report.

Because Dallas is reviewing multiple alternatives to bring water into their system from the IPL, this report does not analyze costs for connection between the IPL and Dallas' delivery point. Costs for many options are included in the Dallas Delivery Location Analysis Technical Memoranda and will be added to these overall project costs after a delivery point and path has been selected. The overall IPL capital cost estimate including the Dallas Delivery option selected in *Amendments 3 and 4 of Phase 1 of the Raw Water Transmission System Integration Study, Report No. 2* is located in Appendix M of this report. **Figure 5-1** identifies the IPL segments and facilities for which costs were developed in this report.

5.1 Cost Parameters and Methodology

Cost opinions were prepared using spreadsheet models. The expected accuracy range, degree of preparation effort, typical estimating method and level of project definition were typical of a conceptual level Class 4 estimate (using AACE International Recommended Practice No. 17R-97 - Cost Estimate Classification System) based on primarily stochastic methods. The cost parameters were based on recent bid tabs from several large diameter pipeline and pump station projects constructed in the Dallas/Fort Worth area and local manufacturers' pipeline unit cost data.

For purposes of this cost analysis, the pipeline was divided into various pipeline segments based upon the potential ownership and cost allocations between TRWD and DWU. **Table 5-1** lists the various pipeline segments and design flow rates.

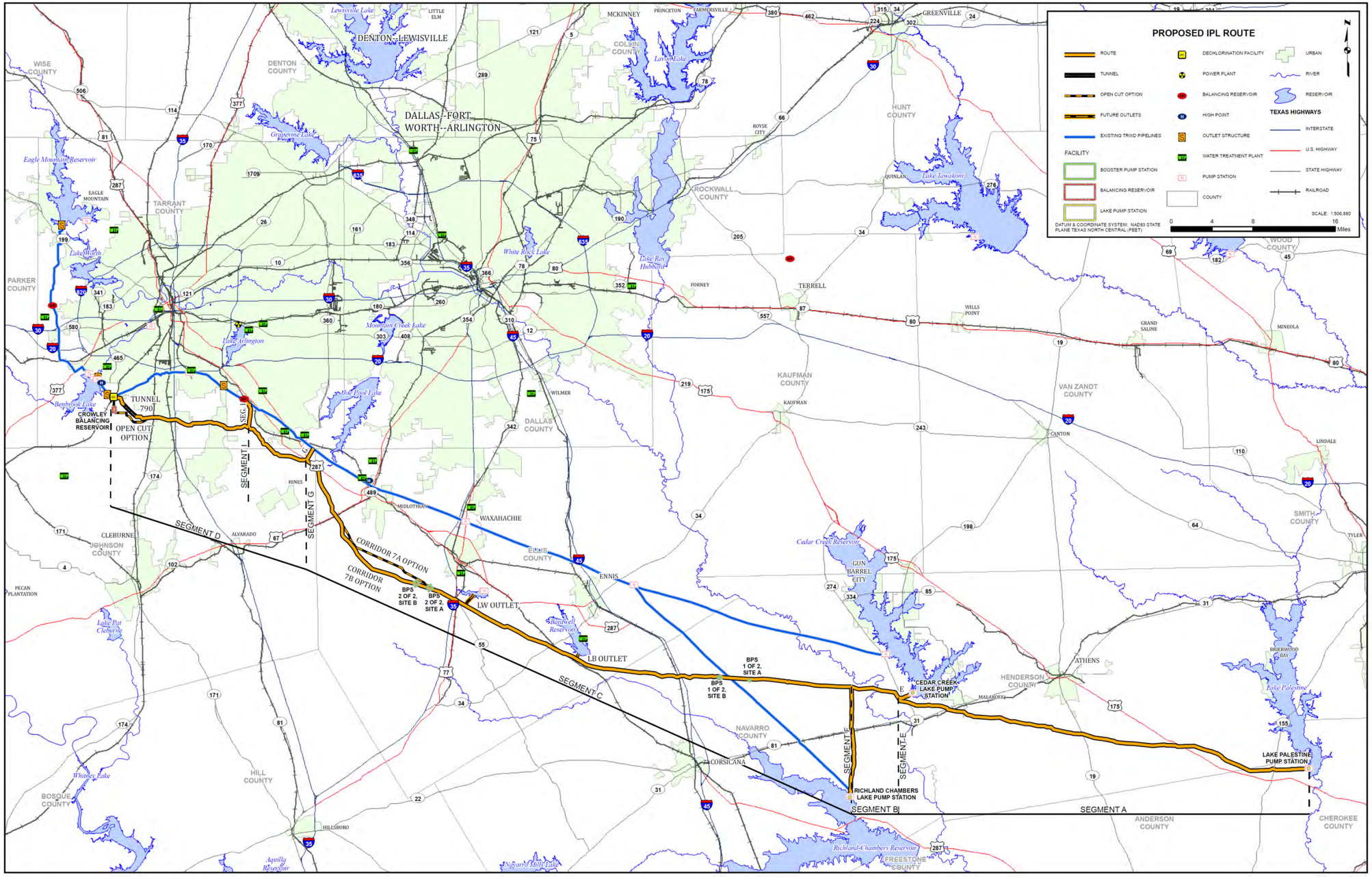

Figure 5-1 Integrated Pipeline Route

Table 5-1. Segment Descriptions

Segment	From	To	Design Flow (MGD)
A	Lake Palestine	Cedar Creek Connection	150
B	Cedar Creek Connection	Richland-Chambers Connection	277
C	Richland-Chambers Connection	Bachman Take-off Point	347
D	Bachman Take-off Point	Connection to Benbrook Pipeline	197
E	Cedar Creek Reservoir	Connection to the Main Proposed Pipeline	127
F	Richland Chambers	Connection to the Main Proposed Pipeline	70
G	Main Proposed Pipeline	Existing TRWD Lines	347
I	Main Proposed Pipeline	Kennedale Balancing Reservoir	197

5.1.1 Energy Cost Calculation Methodology

The energy costs for the transmission of flows through the Integrated Pipeline were determined using the IPL system simulation model (to generate flow time series) and TRWD's 'tariff spreadsheet' (to calculate energy usage and cost). The baseline integrated operating conditions of TRWD and Dallas sub-systems were defined and modeled using the STELLA program and are described in *Amendments 3 and 4 of the Raw Water Transmission System Integration Study, Report No. 1* (see Section 2 of that report). The STELLA model (the system simulation model) was used to calculate the flows transferred from Cedar Creek and Richland-Chambers Reservoirs (TRWD supply sources) and Lake Palestine (Dallas's supply source) through the three transmission pipelines (TRWD's existing CC and RC pipelines and the proposed integrated pipeline). As described in Report No. 1, model simulations were performed assuming no water sharing between TRWD and Dallas, using the hydrologic period-of-record extending from 1941-1986, and using demands representing the projected demand for each decade from 2010 to 2060.

TRWD currently uses a spreadsheet model to determine the energy costs incurred for pumping operations in their existing system. Because TRWD will control integrated system operations, this same model was used in this analysis. Few modifications were made to the spreadsheet model representing current system operations and to incorporate the Integrated Pipeline and the 3-booster and 2-booster pump stations modes of pumping operations. The flows generated by the system simulation model (STELLA) for each decade are put into the spreadsheet model, which then distributes the flows between the three pipelines based on pipeline hydraulics and the optimum flow distribution ratio that results in lowest energy costs for the entire system (existing TRWD pipelines and proposed IPL). Once the flows are distributed, the total dynamic head (TDH) and kilowatts (KW) required to transmit those flows through each pipeline segment between the pump stations are computed.

The total energy cost incurred by TRWD's system operations is comprised of generation costs (this is the cost required to move X amount of kWh through the system) and transmission and distribution costs. The generation costs are computed by multiplying the total kWh required for flow transmission with the costs/kWh factors developed and described in Appendix 5-C of *Amendments 3 and 4 of Phase 1 of the Raw Water Transmission System Integration Study* -

Report No. 1. The generation cost/kWh factors presented in that report were increased by $0.02 to make the generation costs/kWh factors comparable to TRWD's current contracted rates with the electricity providers. The transmission and distribution costs were computed using different distribution cost factors provided by TRWD.

The energy costs for intermediate years between each decade were linearly interpolated from the costs calculated at each decadal demand level. Because determination of the pipeline route was running on a parallel track to all of this cost estimating, it was not possible to determine which electricity provider would be supply to the pump stations. For this analysis, rates were based on current TRWD electricity providers.

The energy costs for different combinations of pipeline routes and pumping options are presented in Appendix A of this report. Demand projections on which these operating costs are based are presented in **Tables 5-2 and 5-3**. Demand values are based on TRWD estimates (using customer input) and Dallas's 2005 Long Range Water Supply Plan Update. Monthly adjustment factors and climate adjustment factors were applied, per direction from TRWD (same as RiverWare input) and Dallas.

Table 5-2. Demand Values (mgd) used for TRWD Customer Demand Nodes

	2010	***2020***	***2030***	***2040***	***2050***	***2060***
Holly WTP	48	50	47	43	39	35
Eagle Mountain WTP	50	65	80	95	110	127
JFK WTP	39	46	49	56	62	69
Pierce Burch WTP	38	38	47	53	59	66
Mansfield WTP	9	13	17	21	25	28
TRA Mosier Valley	38	48	59	69	80	90
Benbrook Local Use	3	4	6	7	8	9
Worth Local Use	4	4	4	4	4	4
Eagle Mountain Local use	2	2	3	3	4	4
Bridgeport Local Use	6	6	8	8	9	10
Arlington Local Use	2	2	2	3	3	3
Richland Chambers Local Use	3	4	4	5	5	5
Cedar Creek Local Use	4	4	5	6	7	8
Northwest WTP	10	13	21	30	41	53
Weatherford	4	4	4	4	4	4
BWSA	2	2	2	2	2	2
SW WTP	0	10	12	15	17	20
Rolling Hills WTP (removed SW WTP)	77	76	81	89	98	106
Ellis County Aggregated (Total Proposed Projections)	49	58	58	58	58	58
Total TRWD Demands	386	446	508	569	634	702

Table 5-3. Demand Values (mgd) used for Dallas Demand Nodes

Westside Lake Level Trigger	When Lewisville is above 520 ft						When Lewisville is below 520 ft					
Decade	2010	2020	2030	2040	2050	2060	2010	2020	2030	2040	2050	2060
Total Dallas Treated Water Demand	501	575	614	637	651	666	501	575	614	637	651	666
Westside System Demand [1, 3]	301	345	368	382	390	399	261	299	319	331	338	346
Elm Fork WTP [2]	195	224	239	249	254	260	169	194	207	215	220	225
Bachman WTP [2]	105	121	129	134	137	140	91	105	112	116	118	121
Eastside System Demand [1 3]	200	230	245	255	260	266	240	276	295	306	312	320
Eastside WTP	200	230	245	255	260	266	240	276	295	306	312	320
Westside System Raw Water Demand [4]	33	51	63	74	86	97	33	32	71	104	140	169
Eastside System Raw Water Demand [4]	3	3	3	3	3	3	3	3	3	3	3	3
Potential Customers [5]	2	2	2	3	3	4	2	2	2	3	3	4
Total Demand (including 5% treatment losses)	566	662	716	752	780	808	566	643	724	784	837	883

[1]Total Dallas Demand is distributed between Westside and Eastside systems in the ratio of 60:40 (When Lewisville >518 ft) and 52:48 (When Lewisville < 518 ft).

[2]Total Westside Demand is distributed between Elm Fork and Bachman WTP in the ratio of 65:35.

[3] Total Demand for each system (Westside and Eastside) is a total of Treated Water Demand, Raw Water Demand, and Demand for Potential Customers.

[4] Raw Water Demands are the demands supplied from Dallas system to other entities.

[5] Demand attributed to potential future demands for customer cities. Potential Demands are equally allocated to Eastside and Westside systems.

5.1.2 Capital Costs Calculation Methodology

Pipeline Costs

Pipeline costs are the most significant component of the overall IPL project estimate. Local pipeline manufacturers were consulted for budget estimates. Some of the assumptions used in the pipeline cost analysis include:

- Steel: Steel pipe will be manufactured and tested in accordance with AWWA C200. Steel grades of 36,000 psi, 42,000 psi, and 48,000 psi were utilized in determining the manufacture's pipeline unit cost estimate.
- Interior Lining: Pipeline will be cement mortar lined.
- Exterior Coating: Buried pipe will be polyurethane coated.
- Lengths: Standard lengths are 50 ft for steel.

Pipeline pressure classes were chosen based on the hydraulic grade lines developed for each pipeline segment as described in Section 4 of this report. **Figure 5-2** is an example of an HGL plot also showing pipe pressure class. Pipeline installation (excavation, bedding and backfill, appurtenances, etc.) costs were developed using recent data from large diameter pipeline installation projects constructed in the Dallas/Fort Worth and east Texas areas.

An itemized list of construction materials and labor used to generate the capital cost estimate is located in Appendix F of this report. **Table 5-4** shows steel pipe unit costs used in this analysis.

Table 5-4. Steel Pipe 2009 Material Unit Costs/Pressure Class

Pipe Diameter (inches)	Unit Cost (CL 150)	Unit Cost (CL 175)	Unit Cost (CL 200)	Unit Cost (CL 225)	Unit Cost (CL 250)
60	$189	$189	$189	$212	$236
66	$223	$223	$223	$250	$279
72	$259	$259	$259	$292	$324
78	$296	$296	$296	$334	$371
84	$339	$339	$344	$382	$425
90	$370	$370	$375	$417	$464
96	$410	$410	$415	$462	$513
102	$456	$456	$456	$513	$569
108	$510	$510	$510	$573	$637
120	$622	$627	$627	$705	$783

Pump Station Costs

Pump Station pricing was developed from bid tabs of similar size projects with similar pump and piping configurations (comparable type, size and number of pumps). Costs for pumps, motors, and drives were estimated based on current pricing provided by manufactures. Costs for pump suction and discharge piping (including headers and yard piping) and valves were estimated using bid tabs from past DWU and TRWD projects.

The use of horizontal split-case pumps was assumed at all booster pump stations. It was also assumed that all pumps at booster pump stations will be equipped with variable frequency drives (VFDs). Horizontal split-case pumps were assumed to be between 20,000 GPM to 30,000 GPM each (approximate pump suction and discharge size = 42” x 36”). For the purpose of estimating, the pump configuration was assumed to be four (4) units for firm capacity plus one (1) backup. Vertical turbine pumps were assumed at all lake intake pump stations, each equipped with a VFD. Vertical turbine pump sizes were assumed to be between 30,000 GPM to 40,000 GPM each. For the purpose of estimating, the pump configuration was assumed to be eight (8) units for firm capacity plus one (1) backup. An itemized list of construction materials and labor used to generate the capital cost estimate is located in Appendix F of this report.

Easement and Real Estate Costs

The easements and property costs were determined based on acquisition costs from recent Dallas Water Utilities and Tarrant Regional Water District large diameter pipeline projects. A 150 ft permanent easement width was assumed to accommodate a future second (and perhaps third) pipeline within the same right-of-way. The acquisition of the pump station sites were also included in the overall cost estimate.

5.1.3 Life Cycle Costs Calculation Methodology

In calculating the lifecycle cost, a 100-year project life was assumed, spanning from 2018 (project commissioning) through 2117, and annual costs were broken down into four categories: debt service, operations and maintenance, energy, and renewal and replacement.

Debt Service

Debt service represents the cost associated with the expected debt financing to pay for the capital costs of each project. For this project, the Dallas and TRWD costs of debt, 4.88% and 5.07%, respectively, were averaged together to yield 4.97%. These costs of debt were then applied to the capital cost of the appropriate scenario and a payment schedule was generated for a 30-year, fixed rate, level payment debt issue.

Operations and Maintenance

The operations and maintenance expenses (O&M) for each scenario were calculated based on historical itemized operation and maintenance information from Dallas Water Utilities.

Table 5-5. Pipeline O&M (not including energy)

Item	First year	Cost/ #year
Project Vehicles - 2 - 4x4 vehicles to drive ROW	$70,000	$0
Gas - Project Vehicles	$7,000	$3,500
Maintenance - Project Vehicles	$2,000	$2,000
ROW maintenance - mowing, clearing, etc.	$236,000	$236,000
CP - Annual Survey - 3 people 1 month	20,000	$20,000
Chemical Feed System	$5,400,000	$5,400,000
Valve Maintenance and replacement	0	$45,000
Labor - 2 people full time @ $34/hour including benefits	$141,000	$141,000

Assumptions:

1. Replace vehicles every 5 years
2. Assume 20k mileage per year @ 18 miles/gal. $3/gal gas
3. Assume tire replacement and fluid changes per year.
4. Mowing and clearing 130 miles of 150-foot wide pipeline ROW @ $100/acre. Mow once per year
5. Assume 3 people for annual survey, test station maintenance, and rectifier maintenance.
6. Based on 350 MGD @ $0.0426/1000 gal. Includes caustic, Chlorine, LAS, Power, Maintenance
7. Assume replacement of 0.5% of total valves per year - 130 miles of pipeline with a valve every 1500-feet.
8. Assume 2 people dedicated to pipeline O&M

Table 5-6. Pump Station O& M

Item	First Year	Cost/ #year
Pump Room HVAC Power	$100,000	$100,000
Pump Room Lighting Power	$10,000	$10,000
Pump Station Operator	$125,000	$125,000
Pump Station general maintenance employee	$80,000	$80,000
Yard and & Landscaping	$5,000	$5,000
Security Service	$100,000	$100,000
Pump Rebuild Maintenance (10-yr cycle)/pump	$15,000	$15,000
Roof Maintenance	$0	$30,000
Painting	$0	$15,000
Intake Screens	$3,000	$3,000
Motor Cooling System Maintenance	$3,000	$3,000
Bridge Crane Maintenance	$3,000	$3,000

Assumptions per pump station:

1. Including fringe benefits
2. Onsite guard service
3. Add cost every 10 years
4. Replace every 30 years
5. Repaint every 5 years

5.2 Cost Analysis Results

Based on the parameters and methodology described in Section 5.1, the following capital and life-cycle cost estimates were generated. **Table 5-7** summarizes the capital cost for the Integrated Pipeline route and facilities recommended in this report. **Table 5-8** contains energy cost estimates for each decade of operations based on the baseline operating conditions developed during this study. The full Operations Study that will be completed in the next phase of this IPL Project will define operating conditions more specifically and refine these operating costs. Using the values in Tables 5-7 and 5-8, the present worth of the 100-year life-cycle cost is **$3,053,000,000.**

Table 5-7 IPL Capital Costs

COST ESTIMATE SUMMARY | **SCENARIO** VE validated w/o Dallas Delivery

2009 Prices	***INTEGRATED PIPELINE PROJECT***	Date: 6/25/2010

Item		Estimated Costs for Facilities
Capital Costs		
Pipelines		
Segment A - Lake Palestine to Cedar Creek Reservoir	$	222,556,000
Segment B - Cedar Creek to Richland-Chambers Tie-in	$	43,597,000
Segment C - Richland-Chambers Tie-in to Segment G Connection	$	514,880,000
Segment D - Seg G Connection to Lake Benbrook	$	181,894,000
Segment E - Cedar Creek to Main Trunkline	$	8,040,000
Segment F - Richland-Chambers to Main Trunkline	$	45,388,000
Segment G - Main Trunkline to Existing TRWD Pipelines	$	11,790,000
Segment I - KBR Cross Connection	$	19,363,000
Pipelines Subtotal	$	1,047,508,000
Land Acquisition		
Segment A	$	34,811,000
Segment BCDE	$	83,482,000
Segment F	$	5,990,000
Segment G	$	1,505,000
Segment I	$	3,070,000
Land Subtotal	$	128,858,000
Pump Stations		
Lake Palestine Intake and PS		$51,627,000
Richland-Chambers Lake PS		$23,980,000
Cedar Creek Intake and PS		$47,285,000
Booster PS 1		$68,989,000
Booster PS 2		$68,989,000
Pump Stations Subtotal	$	260,870,000
Power Supply	$	30,000,000
Total Project Capital Cost	**$**	**1,467,236,000**
Escalation @ 3% to mid point of construction (2015)	**$**	**1,700,910,000**

CDM

Table 5-8 Energy Costs per Decade

IPL - Energy Costs Per Decade					
2010	2020	2030	2040	2050	2060
$21,106,000	$25,661,000	$39,091,000	$57,931,000	$79,921,000	$100,099,500

5.3 Integrated vs. Independent Project Development

From the beginning of this project, the Raw Water Transmission System Integration Study which later became known as the Integrated Pipeline Project, the question we sought to answer was: Should TRWD and DWU develop two independent water transmission projects or one integrated water transmission project? The technical aspects of this question were answered in previous reports and a definitive conclusion was reached that 'yes', integration should proceed. This decision rested in large part on the potential cost savings to both TRWD and Dallas in developing a joint project as opposed to two independent raw water conveyance systems.

Cost estimating methods and detail have continued to improve and project definition has improved. At this final stage of planning, it is prudent to again calculate the project cost for the TRWD and Dallas independent project development alternatives and compare them to the IPL configuration. **Table 5-9** contains the results of that comparison. It shows that **significant cost savings will be realized by developing an integrated raw water transmission system as compared to developing independent systems, savings in the range of $375 to $443 million in capital cost and roughly $1 to $1.5 billion in present worth 50-year life-cycle cost.**

Tabel 5-9 Integrated vs Independent Comparisons

COST ESTIMATE SUMMARY		SCENARIO	Comparison of Integrated and Baseline Alternatives

2009 Prices	*Integrated vs Independent*	Date:6/27/10

Parameter	Project Alternative			
	TRWD-Dallas Integrated Pipeline	***TRWD Independent Pipeline***	***Dallas Independent Pipeline - Pal to SE WTP***	***Dallas Independent Pipeline - Pal to Bachman WTP***
Pipeline Segments Included	A through I	B, C, D, E, F	A	A, B, C, G, H
Total Pipeline Length	933,808	522,322	466,021	717,859
Tunnel Length (i.e. deep tunnels, not crossings)	8,480	8,480	0	0
Pipeline Diameter	Segment A-84"; B-108"; C-108", D-84", E-72", F-66", G-108", H-84", I-84"	Segment B-72"; C-90"; D-90", E-72", F-66"	Segment A-84"	Segment A-84"; B-84"; C-90", G-84", H-84"
Number of Booster Pump Stations	2	2	2	2
Number of Intakes and Intake Pump Stations	3 PS, 2 new intakes	2 PS, 1 new intake	1 intake and PS	1 intake and PS
Design Flow	Segment A-150, B-277, C-347; D-197; E-127; F-70; G-197; H-150; I-197	B, E-127; C, D-197; F-70	All - 150	All - 150
Route	Follows Corridor 1/7 as finalized on xx/xx/2010. Runs between CC/RC, south of Lakes Bardwell and Wax., etc……	Follows same route as Integrated Pipeline alternative	-----	-----
Total Land Acquired (acres)	2681	1799	1605	2473
Number of Storage Facilities	1	1	1	1
Total Capital Cost (2009 $)	**$1,726,561,000**	**$977,845,000**	**$1,123,265,000**	**$1,192,079,000**
Energy Usage and Cost: 2010	$21,106,000	$18,709,000	$6,083,000	$8,216,000
Energy Usage and Cost: 2020	$25,661,000	$30,306,000	$10,701,000	$14,455,000
Energy Usage and Cost: 2030	$39,091,000	$46,594,000	$14,506,000	$19,596,000
Energy Usage and Cost: 2040	$57,931,000	$64,653,000	$18,218,000	$24,610,000
Energy Usage and Cost: 2050	$79,921,000	$82,450,000	$22,469,000	$30,351,000
Energy Usage and Cost: 2060	$100,100,000	$96,461,000	*$26,063,000*	$35,206,000
50-year Life-cycle Cost Present Worth	**$2,926,430,000**	**$2,170,296,000**	**$1,762,727,000**	**$1,917,380,000**

Section 6
Recommendations

This report section is meant to provide summary information about the recommended pipeline route in a tabular format. In the sections below are tables that describe the configuration of the recommended route.

In report Section 2, the configuration of the recommended Integrated Pipeline Project (IPL) route was described in specific detail. The IPL is divided into 8 parts that describe Segments A through I. The overall system configuration is shown in **Figure 6-1**. Detailed hydraulic analysis and cost estimating helped develop the optimum pipeline diameters for the IPL project. As a result of the analysis, there is a recommended deep tunnel in Segment D near Crowley. This tunnel is approximately 8,500 feet in length and has both hydraulic and social benefits to the project. This recommendation will also be refined and verified during the Conceptual Design and Operations Study phase. The recommended configuration of the pipeline is noted in **Table 6.1**.

Table 6-1. IPL Configuration

Segment	From	To	Pipeline Diameter	Flow Rate (MGD)	Pipeline Length
A	Lake Palestine	Cedar Creek Connection	84”	150	220,394’
B	Cedar Creek Connection	Richland-Chambers Connection	108”	277	26,159’
C	Richland-Chambers Connection	Bachman Take-off Point	108”	347	329,388’
D	Bachman Take-off Point	Connection to Benbrook Pipeline	84”	197	114,131’
E	Cedar Creek Reservoir	Connection to the Main Pipeline	72”	127	8,517’
F	Richland-Chambers	Connection to the Main Pipeline	66”	70	57,768’
G	Main Pipeline	Existing TRWD Lines	108”	347	7,120’
I	KBR Take-off Point from Main Pipeline	Kennedale Balancing Reservoir	84”	197	14,765’

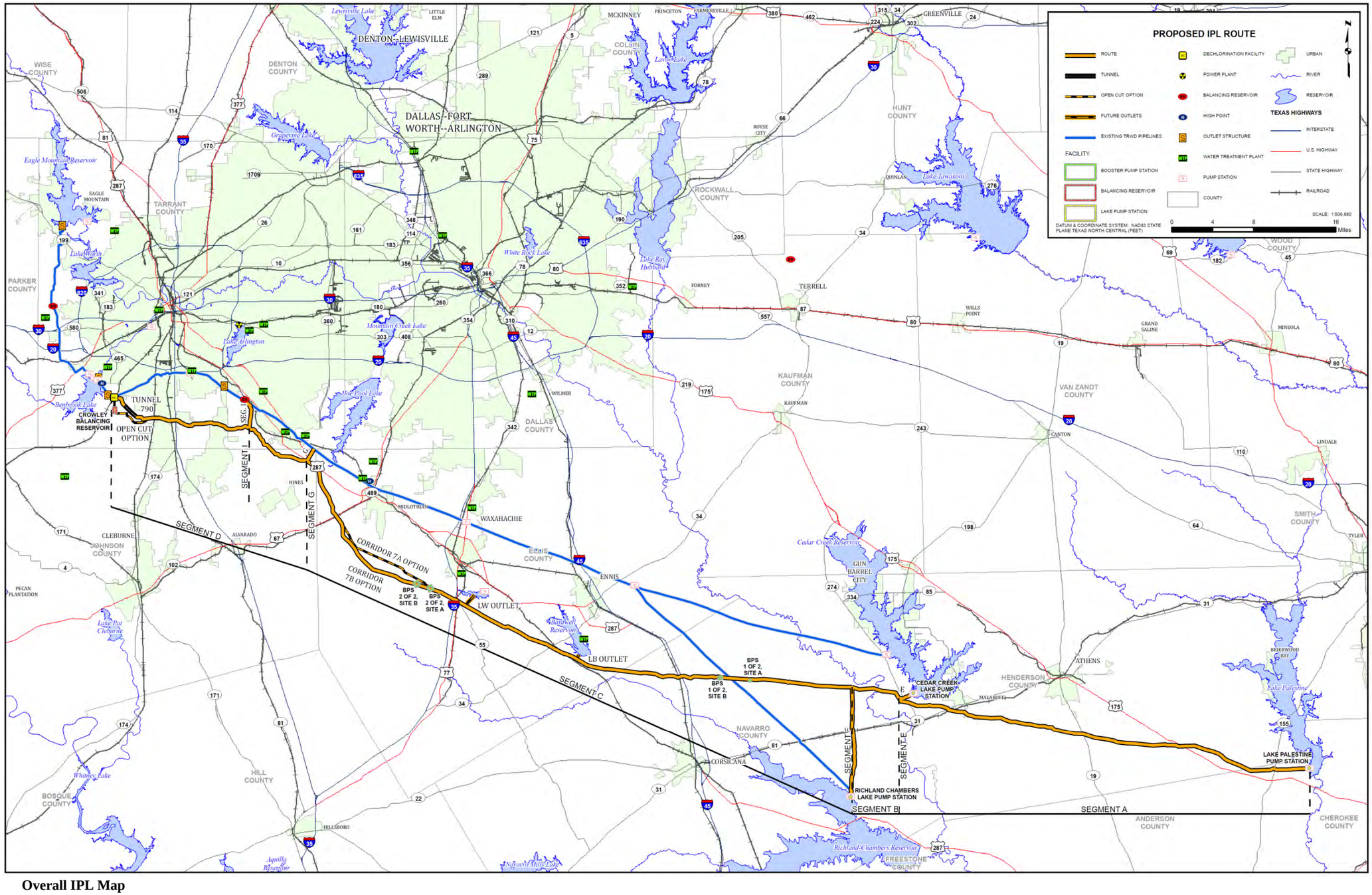

Figure 6-1. Overall IPL Map

The number of recommended facilities for the IPL project was studied in detail in this report and in previous studies. The recommended number of facilities and their locations were based on preliminary hydraulics calculations, capital costs, energy costs, and life cycle analyses. **Table 6-2** notes the number and of facilities and their pumping configuration.

Table 6-2. IPL Facilities

Facility	Flow Rate (MGD)	Operating Head Range	Number of Pumps
Lake Palestine Pump Station	150	210' – 625'	4 + 1
Cedar Creek Pump Station	127	136' – 378'	4 + 1
Richland Chambers Pump Station	70	143' – 396'	3 additional
Booster Pump Station No. 1	350	263' – 577'	6 to 8 + 1
Booster Pump Station No. 2	350	152' – 582'	6 to 8 + 1

In the previously submitted corridor selection report (*Amendment 3 and 4 Report No. 2*), there was a comparative analysis done for multiple corridors. The evaluation criteria used to differentiate the corridors has been used in this report to provide an overall and detailed view of the recommended route. **Table 6-3** is a criteria summary table for the IPL route.

Table 6-3. Evaluation Criteria Summary Table

Criteria	Unit	Quan/Qual
Number of Acquisitions (Parcels) - Total IPL	No.	877
Major Utility Xings/CCN Utility Bndry Xings	No.	26
State and US Highway Crossings	No.	19
Railroad Crossings	No.	6
Oil/Gas Line Crossings	No.	40
Pipeline Length (total IPL)	Ft	778,242
Urban Pipeline Length (Total IPL)	Ft	42,366
Major River Crossings (Total IPL)	No.	1
Stream Crossings	No.	210
Archeological and Historical Sites	No.	5
Lake and Pond Crossings	No.	42
Forested upland	ac	255
Forested Bottomland	ac	82
Native Grasslands	ac	626
Endangered Species Habitat	ac	207
USACE Property	ac	6
Pipeline Construction Costs (IPL Total)	$M	$1,047

Table 6-3(cont.). Evaluation Criteria Summary Table

Criteria	Unit	Quan/Qual
Easement Costs (IPL Total)	$M	$128
Energy Costs (IPL Total) Present Worth	$M	$895
Power Supply Costs	$M	$30
Fault Crossings	No.	5
Alluvial Soils	Ft	32,925
Terrace Soils	Ft	2,411
Native Soils	Ft	126,552
Tunnels (all are stream, highway, drainage crossings)	Ft	7,126
Deep Tunnels	Ft	8480
Rock Excavation	Ft	122,458
Levee Crossings (USACE)	No.	0
OH and UG power crossing	No.	41
Major Highway Crossings	No.	46
County Road/Local Street Crossings	No.	104
100-year Flood Plain	No.	56
Minimize Overall Pumping	Hp	100,306
Number of Redundant Power Supply Sources	No.	2

The detailed cost spreadsheets and tables noted in this report have been validated by the Program Manager's Value Engineering (VE) team. Most of the recommendations and cost estimating methodologies were adopted and incorporated into this final report after the VE workshops held through the week of May 17, 2010.

This report presents the preliminary capital and life cycle costs associated with the IPL project. Cost opinions were prepared using spreadsheet models. The expected accuracy range, degree of preparation effort, typical estimating method and level of project definition were typical of a conceptual level Class 4 estimate (using AACE International Recommended Practice No. 17R-97 - Cost Estimate Classification System) based on primarily stochastic methods. The cost parameters were based on recent bid tabs from several large diameter pipeline and pump station projects constructed in the Dallas/Fort Worth area and local manufacturers' pipeline unit cost data. Preliminary 2009 capital cost for the IPL project is approximately $1.47 B (escalated to 2015 construction mid-point this is $1.7 B). Detailed cost spreadsheets are located in Appendix F of this report. **Table 6-4** notes the capital costs for each pipeline segment and facility.

Table 6-4. IPL Capital Costs

Segment/Facility	Descriptions	Length (feet)	Design Flow	Capital Cost
Segment A	From Lake Palestine to Cedar Creek Lake	220,394	150	$222,556,000
Segment B	From Cedar Creek to Richland Chambers tie in connection	26,159	150	$43,597,000
Segment C	From Richland Chambers tie-in connection to Bachman turn-out	329,388	347	$514,880,000
Segment D	From Bachman turn-out to Benbrook	114,131	197	$181,894,000
Segment E	From Cedar Creek to IPL	8,517	127	$8,040,000
Segment F	From Richland Chambers to IPL	57,768	70	$45,388,000
Segment G	From main IPL to existing TRWD pipeline	7,120	347	$11,790,000
Segment I	From IPL to KBR	14,765	197	$19,363,000
Lake Palestine	Lake Intake Pump Station	n/a	150	$51,627,000
Cedar Creek Lake	Lake Intake Pump Station	n/a	127	$47,285,000
Richland Chambers	Lake Intake Pump Station	n/a	70	$23,980,000
BPS1	Booster pump station 1	n/a	347	$68,989,000
BPS2	Booster pump station 2	n/a	347	$68,989,000
Land Acquisition	All pipeline and facilities (acres)	n/a	n/a	$128,858,000
Power Supply	Power connection to the pumping facilities	n/a	n/a	$30,000,000

Table 6-5 contains energy cost estimates for each decade of operations based on the baseline operating conditions developed during this study. The full Operations Study that will be completed in the next phase of this IPL Project will define operating conditions more specifically and refine these operating costs. Using the values in Tables 6-4 and 6-5, the present worth of the 100-year life-cycle cost is **$3,053,000,000.**

Table 6-5. IPL Energy Costs

IPL - Energy Costs Per Decade					
2010	2020	2030	2040	2050	2060
$21,106,000	$25,661,000	$39,091,000	$57,931,000	$79,921,000	$100,099,500

Section 7
References

Geologic mapping along the entire pipeline route is currently available from the Tyler Sheet and the Dallas Sheet of the Geologic Atlas of Texas at a scale of 1:250,000. This information has been used to develop the site geologic map in Figure 1-1.

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Tarrant Regional Water District/ City of Dallas

SUMMARY REPORT

Project Viability Assessment and Business Case Evaluation of Raw Water Transmission System Integration

July, 2008

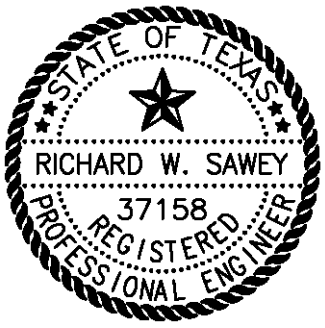
CDM/KBR

In Association with: R.W. Beck, KStrategies, TRC/Brandes, Espey Consultants, Inc., Patrick, Miller & Kropf, P.C., Crespo Consulting Services, Inc.

TARRANT REGIONAL WATER DISTRICT / CITY OF DALLAS

SUMMARY REPORT

PROJECT VIABILITY ASSESSMENT AND BUSINESS CASE EVALUATION OF RAW WATER TRANSMISSION SYSTEM INTEGRATION



July, 2008

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Executive Summary

The Tarrant Regional Water District (TRWD) and the City of Dallas Water Utilities (DWU) have developed a comprehensive list of new water management strategy recommendations that include connecting Lake Palestine to the DWU water system; completion of the TRWD constructed wetlands, and construction of TRWD's Third East Texas Pipeline from Cedar Creek and Richland-Chambers Reservoirs in approximately 2015. The geographic proximity of Lake Palestine to the existing TRWD water supplies and raw water transmission facilities at Cedar Creek and Richland-Chambers Reservoirs (as shown in **Figure ES-1**) and the similarity between the proposed implementation of these water supply strategies prompted DWU and TRWD to begin preliminary discussions about an opportunity to explore an integrated approach to bring additional water into the Dallas and Tarrant Regional Water District service areas.

The purpose of this initial Project Viability Assessment and Business Case Evaluation was to 1) identify any "fatal flaws" to developing an integrated raw water transmission system; and 2) compare the separate, independently adopted water strategies of both TRWD and DWU with integrated raw water delivery system alternatives in terms of their life-cycle cost implications, water quality and treatment implications, and permitting and environmental issues. In other words, this study compared the current water supply plans of each agency with integrated raw water transmission system alternatives.

Six tasks were completed as part of this initial Project Viability Assessment and Business Case Evaluation.

1. Integrated system operations analysis;
2. Capital and life-cycle cost analysis;
3. Facility siting constraints assessment;
4. Environmental water quality review;
5. Consideration of water treatment impacts; and
6. Permitting and regulatory review.

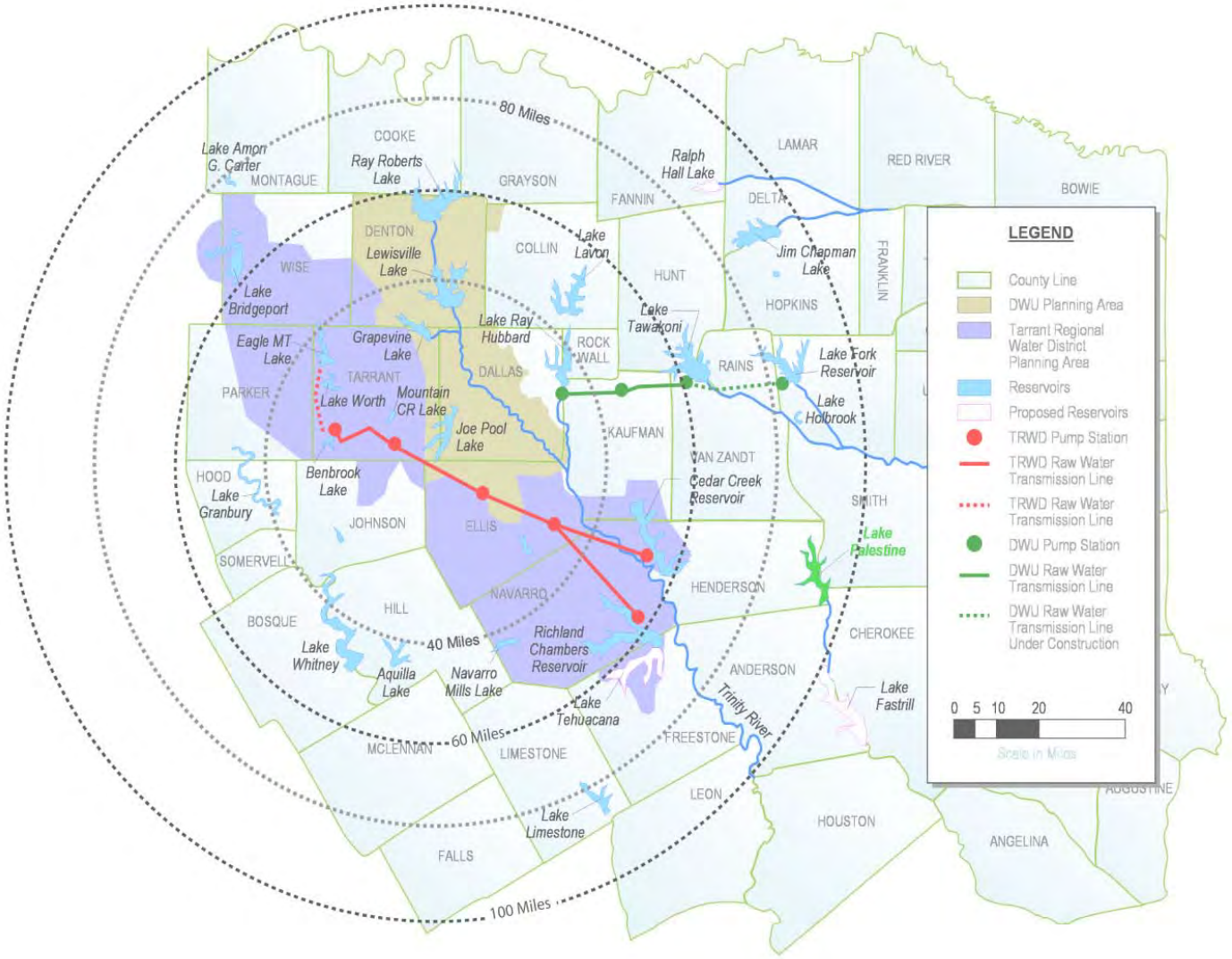

Figure ES-1
Vicinity Map

Several key objectives must be met to make a successful Business Case Evaluation that an integrated system could complement or replace existing, independent water supply plans:

- An integrated raw water transmission system alternative must enhance the redundancy, flexibility, and demand risk management of the existing water supply systems;
- An interconnected plan must make sufficient water supply available to meet demands where and when needed, under a full range of historical hydrological conditions;
- An integrated raw water transmission system alternative must reduce capital and life-cycle costs, while not contributing to unmitigated treatment or distribution costs for DWU or TRWD customers; and
- All scenarios must fully consider societal, environmental, and regulatory complexities

With these key objectives guiding the way, four project conveyance alternatives were developed through a progressive screening approach to evaluate combinations of conveyance infrastructure and interconnections, and by then selecting two Baseline Alternatives (independent water strategies) and the two most promising Interconnection Alternatives (integrated delivery systems), as described in **Table ES-1**. Additional treatment and water transmission facilities for DWU that may be required for an integrated strategy but were beyond the study boundary were also considered in this analysis (see Section 7). **Figure ES-2** maps all pipeline routes used in these project alternatives.

Table ES-1
Project Conveyance Alternatives

Alternative	Description
1 (Baseline)	**Independent Systems**: TRWD's East Texas Third Pipeline and DWU's connection of Lake Palestine to the proposed Southeast Water Treatment Plant
2 (Baseline)	**Independent Systems**: TRWD's East Texas Third Pipeline and DWU's connection of Lake Palestine to Joe Pool Lake
3 (Interconnection)	**Integrated System**: Interconnected Third Pipeline (upsized as compared to the baseline condition) with connection of Lake Palestine to Cedar Creek Reservoir and delivery to DWU at Joe Pool Lake and TRWD's customers through the Third Pipeline
4 (Interconnection)	**Integrated System**: Interconnected "Southern Pipeline" - Lake Palestine delivered to the Lake Benbrook pipeline via a pipeline route to the south of the TRWD Third Pipeline route. Delivery to DWU at Joe Pool Lake and TRWD's customers through connections to the existing system and the Lake Benbrook pipeline.

Conveyance Alternative 4 (Interconnected Southern Pipeline)

Interconnected Southern Pipeline (Alt 4)

Alternative	Description	Diameter (inches)	Length (miles)	Design Flow (with Peaking) (mgd)
4	Southern Pipeline		148	
	Palestine to CC/RC Connections	72	47	128
	CC/RC Connections to Benbrook Pipeline	108	70	331
	CC Connection to Southern Pipeline	72	8	127
	RC Connection to Southern Pipeline	66	8	76
	Southern Pipeline Connection to Joe Pool	108	16	331

Legend
- PS — DWU PumpStations
- PS — TRWD PumpStations
- WTP — WTP Locations
- TRWD Lakes
- Lake Palestine
- DWU Lakes
- Interconnected Southern Pipeline

0 50,000 Feet
1 inch equals 50,000 feet

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Figure ES-2

Preliminary Findings

Based on the findings of this Project Viability Assessment, **Table ES-2** lists the potential advantages available to both DWU and TRWD if Lake Palestine is delivered through Interconnection Alternatives 3 or 4. The table also provides some explanation of these advantages or disadvantages.

Table ES-2
Preliminary Findings

Potential Interconnection Advantages	Benefit to DWU	Benefit to TRWD	Notes
Reduced Operating Costs	✓	✓	Operating costs within bounded system are lower in interconnected alternatives as compared to baseline alternatives. Savings more pronounced in near term and decrease over time. Near-term savings attributable to full Lake Palestine supply not being required immediately.
Water Sharing, Timing, Phasing	✓	✓	Even under drought conditions in 2020, ~80 additional mgd could be available. Portion of Lake Palestine supply required before 2020 (if DWU demand reaches 102 mgd) but could be phased through 2030. TRWD requires new water supply (above constructed wetlands) between 2030 and 2040. TRWD can sell or trade water and DWU can defer costs. Water sharing possible between both entities in short term, and in long-term during emergency situation or localized drought condition.
Demand Risk Management	✓	✓	Sharing water between the two water providers can help mitigate effects of unforeseen demand growth patterns in the TRWD or DWU systems.
Water Availability	✓	✓	Supply is limited by the permitted amounts, not water availability. During normal hydrologic periods, extra supply is available through 2060 in an interconnected system. Opportunity for both groups to benefit from this water.
Redundancy	✓	✓	Water supplier can select from multiple supply sources in times of emergency, drought, failure, etc. Opportunity for supply and failure risk management. More alternative flow pathways and connections to multiple water and power sources. Impacts of climatic variations are lessened because of diversification of reservoir locations (an interconnected system "casts a wider net").

Potential Interconnection Advantages	Benefit to DWU	Benefit to TRWD	Notes
Operational Flexibility	✓	✓	Multiple flow pathways could be used to transport water. Capitalize on advantageous opportunities for blending of sources, pump cycling schedules, system maintenance and energy management. Potential disadvantage is potential for increased operational complexity Ability to overdraft supply sources provides flexibility to system operations, the potential for lower operating costs, and risk mitigation
Regional Cooperation	✓	✓	Groundwork for interconnecting future water supply sources (Toledo Bend, Oklahoma, etc.), increasing portfolio of water supply options, reducing costs of right-of-way through earlier acquisition, providing financing risk management, facilitation of future interlocal agreements, and compliance with TWDB planning guidelines
Reduction in Life-cycle Costs	✓	✓	[1]Alternative 3 vs. 2: $537,954,000 Savings Alternative 4 vs. 2: $36,644,000 Savings
Reduction in Capital Costs	✓	✓	Alternative 3 vs. 2: $219,394,000 Savings Alternative 4 vs. 2: –$51,919,000
Environmental Water Quality	—	—	A moderate impact related to higher nutrient concentrations from Palestine will not likely affect the designated uses of the receiving reservoirs
Water Treatment Impact	—	—	Low to moderate impact on water treatment at existing and proposed WTP's. Primary impacts relate to Palestine's low alkalinity, high TOC, and high manganese concentrations
Environmental Impacts / Siting Constraints	—	—	No fatal flaws in pipeline corridors, all are potentially viable and can be recommended for further analysis. No significant differentiators between project alternatives in terms of land use, environmental, or technical (engineering) constraints
Permitting and Regulatory Issues	—	—	No fatal flaws.

[1] Interconnected Alternatives 3 and 4 deliver water to Joe Pool Lake. Baseline Alternative 2 also delivers to Joe Pool Lake but Baseline Alternative 1 delivers to the Southeast WTP. Comparisons were therefore made to Baseline Alternative 2 in this summary table because it is the most apt comparison. In subsequent report sections, comparisons with Alternative 1 are provided.

Recommendations

Based on the findings of the Business Case Evaluation in this study, **Table ES-3** summarizes a comparison of positive or negative impacts of interconnection alternatives vs. baseline plans in a Triple Bottom Line Matrix.

Table ES-3
Triple Bottom Line Matrix
Comparison of Interconnection and Baseline Alternatives

Project Element	Economic	Environmental	Social
Capital Costs	+		
Life-cycle Cost	+		+
Water Treatment Implications	–		
Permitting/Constraints	+	–	
Environmental Water Quality		–	
Water Sharing and Timing, Redundancy, Flexibility	+	+	
Regional Cooperation and Future Water Supply	+	+	+
Ellis County Service			+

This study concludes that interconnecting Lake Palestine through the TRWD system is viable – no fatal flaws have been detected in this study – and that the business case is sufficiently strong to recommend proceeding with more detailed study.

Phase II Analysis

The purpose of this study was to compare separate, independently adopted water strategies with integrated raw water delivery system alternatives, and not to select a preferred integration alternative. Though conceptual engineering and operational scenarios were studied in this effort, further analysis is needed to select a preferred integration alternative and to more fully develop how such a joint project would be planned, designed and operated to optimize economic and operational benefits to both systems. This subsequent effort must be initiated quickly due to impending supply constraints and is paramount to support development of institutional agreements and a financing strategy that will be required. It is

recommended that TRWD and the City of Dallas proceed to a Conceptual Design Phase (see Section 9 for additional detail), the purpose of which is to further develop:

- The conveyance alternatives (with more detailed hydraulic and operational analysis);
- The phasing potential of an integrated plan; and
- The cost analysis based on additional conceptual design details.

This will, in turn, support parallel organizational discussions regarding cost- and gain-sharing and the terms of a long-term institutional framework. At the conclusion of the conceptual design phase, both parties should have sufficient decision support to consider moving forward with detailed final design and construction of an interconnected raw water transmission system or independent water supply alternatives.

Data and Limitations

A short list of some of the primary project assumptions and limitations are shown below. Also, some of the key project data are summarized in **Table ES-4** to facilitate the reader's understanding of the size and scope of potential infrastructure.

- All scenarios for independent and joint water management were predicated on the assumption that DWU will utilize the full contractual yield from Lake Palestine (102 mgd) in all future years. This assumption was held constant even if some of the 102 mgd could originate from TRWD water sources in an interconnected system. This assumption was adopted for comparative purposes, and to limit the number of potential scenarios in this fatal flaw analysis by bracketing the results with limits that will not be exceeded when additional detail is added to subsequent analyses.
- This analysis used cost information and methods established in guidelines published by the Texas Water Development Board (TWDB) for use in regional water planning activities. Therefore, cost opinions were screening- or feasibility-level estimates. Unit costs were from 2006 estimates and were inflated to 1st quarter 2008 dollars. Water treatment costs are based on 2008 cost opinions.
- The water quality analysis was based on a mass balance to analyze broad impacts of blending water from Lake Palestine with the different receiving reservoirs.

Table ES-4
Information on Potential Infrastructure

Alternative	Description	Diameter (inches)	Length (miles)	Design Flow (with Peaking) (mgd)
1	Lake Pal to SE WTP	84	88	184
2	Lake Pal to Joe Pool Lake	84	105	184
1 and 2	Baseline Third Pipeline		103	
	Cedar Creek to Ennis PS	72	26	127
	Richland Cambers to Ennis PS	60	30	76
	Ennis PS to Kennedale Bal Res	84	42	203
	Kennedale Bal Res to RHWTP	96	6	203
3	Interconnected Third Pipeline		139	
	Lake Palestine to Cedar Creek	72	35	128
	Cedar Creek to Ennis PS	96	26	255
	Richland Cambers to Ennis PS	60	30	76
	Ennis PS to RH WTP	108	42	331
	Bal Res to RHWTP	126	6	331
4	Southern Pipeline		148	
	Palestine to CC/RC Connections	72	47	128
	CC/RC Connections to Benbrook Pipeline	108	70	331
	CC Connection to Southern Pipeline	72	8	127
	RC Connection to Southern Pipeline	66	8	76
	Southern Pipeline Connection to Joe Pool	108	16	331

Section 1
Introduction

1.1 Project Background

The Tarrant Regional Water District (TRWD) and the City of Dallas Water Utilities (DWU) own or hold water rights or contracts for a combined 14 surface water reservoirs and provide raw water transmission facilities for many cities and water agencies across North Central Texas. Dallas supplies treated and raw water to wholesale customers in Dallas, Collin, Denton, Ellis, and Kaufman Counties. TRWD supplies raw water and transmission services to Tarrant and 8 other counties in Region C and Johnson County in the Brazos G Region. Through 58 wholesale water agencies and cities and the DWU retail water operations, TRWD and DWU provide drinking water to 4.4 million people, a population that is expected to double in the next 50 years.

DWU has water rights for connected and unconnected surface water supplies totaling 1.8 million acre-feet per year or 1,618 million gallons per day (mgd). According to the *Long Range Water Supply Plan 2005 Update,* the actual average daily firm yield projected for 2060 is much less at 582.4 mgd (average daily). According to guidance in the Texas Water Development Board's *Exhibit B – Guidelines for Regional Water Plan Development,* "Firm yield is defined as the maximum amount of water a reservoir can provide each year during a drought of record using reasonable sedimentation rates and reasonable predetermined withdrawal patterns, assuming full utilization of upstream and downstream senior water rights and full satisfaction of environmental flow requirements and bay and estuary requirements if they apply." In general, the drought of record for North Central Texas reservoirs occurred during the drought of the 1950's.

Current population projections and water demand trends as developed in the Region C Water Plan and the 2005 Update of the Dallas Long Range Water Supply, as illustrated in **Figures 1-1a** and **1-1b**, have resulted in a comprehensive list of new water management strategy recommendations which include connecting Lake Palestine to the DWU water system, completion of the TRWD constructed wetlands, and construction of TRWD's Third East Texas Pipeline from Cedar Creek and Richland-Chambers Reservoirs in approximately 2015.

The geographic proximity of Lake Palestine to the existing TRWD water supplies and raw water transmission facilities at Cedar Creek and Richland-Chambers Reservoirs (as shown in **Figure 1-2**) and the similarity between the proposed implementation of these water supply strategies prompted DWU and TRWD to begin preliminary discussions about an opportunity to explore the conceptual feasibility of an integrated approach to bring additional water into the Dallas and Tarrant Regional Water District service areas.

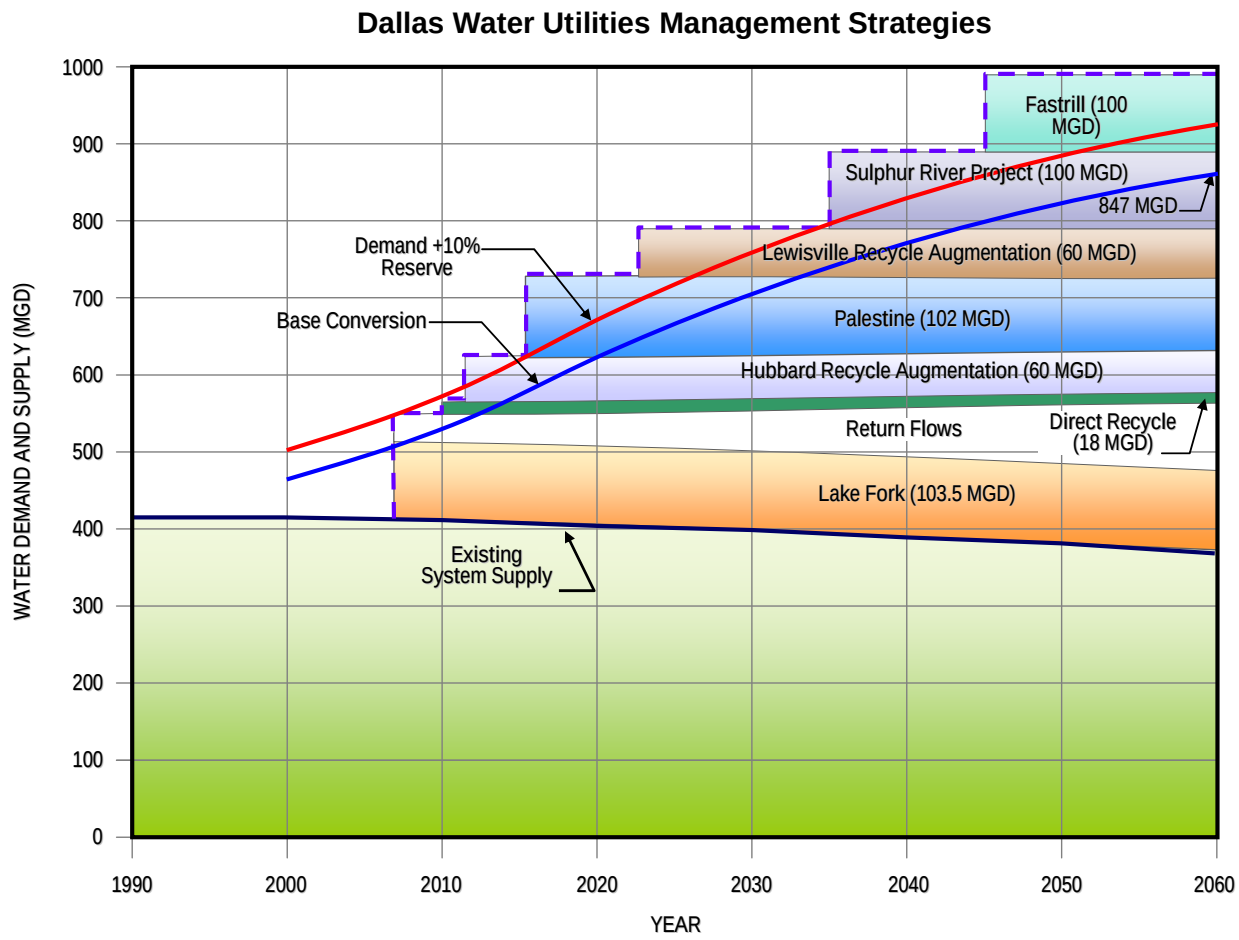


Figure 1-1a
DWU Water Management Strategies
(Figure from December 6, 2006 City Council Briefing)

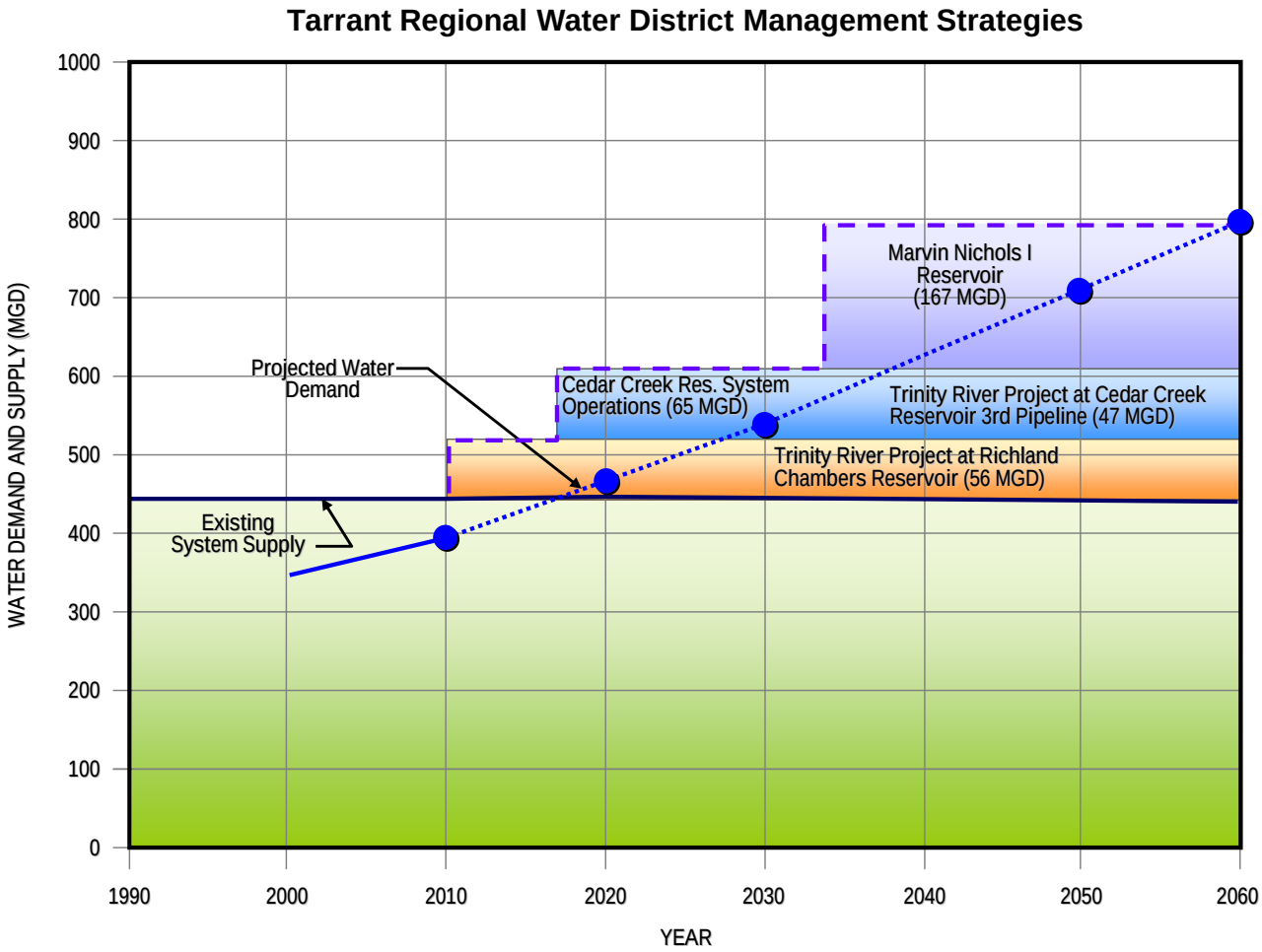


Figure 1-1b
TRWD Water Management Strategies

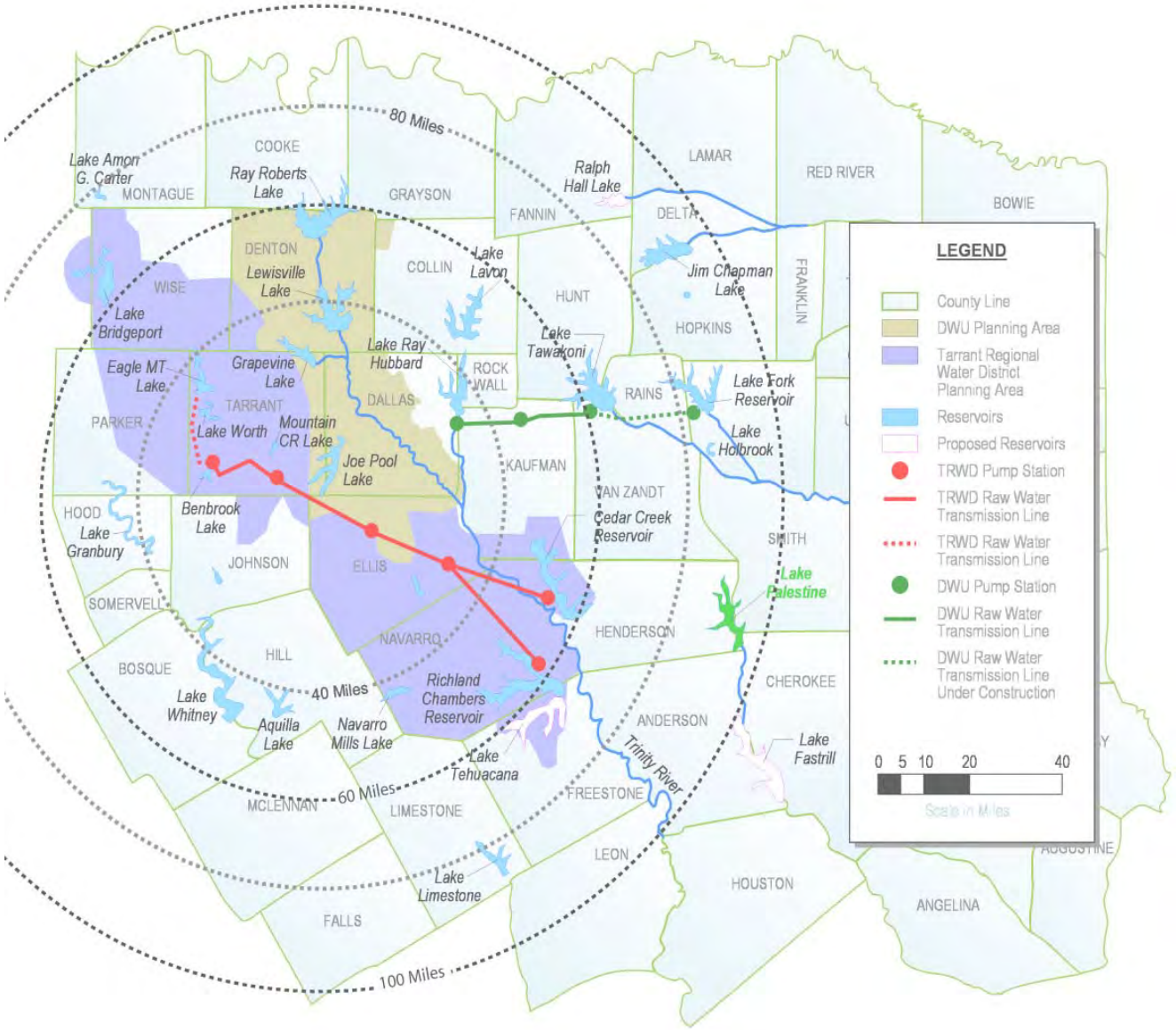


Figure 1-2
Vicinity Map

TRWD and DWU have a long history of cooperation in water supply planning, including the Texas Water Development Board regional water planning efforts initiated by the 1997 passage of Senate Bill 1 in the 75th session of the Texas Legislature. Implementation of Senate Bill 1 led to the creation of 16 regional water planning groups and the development of regional water plans that are updated every five years. The latest adopted regional water plans occurred in 2006 which led to the adoption of the 2007 State Water Plan. This study is intended to complement these ongoing regional plan updates by providing a focused initial project viability assessment and business case evaluation of integrating the TRWD and DWU raw water transmission systems, **Figure 1-2**.

1.2 Project Scope and Purpose

The purpose of this initial Project Viability Assessment and Business Case Evaluation was to 1) identify any "fatal flaws" to developing an integrated raw water transmission system; and 2) compare the separate, independently adopted water strategies of both TRWD and DWU with integrated raw water delivery system alternatives in terms of their life-cycle cost implications, water quality and treatment implications, and permitting and environmental issues. In other words, this study compared the current water supply plans of each agency with integrated raw water transmission system alternatives.

Six tasks were completed as part of this initial Project Viability Assessment and Business Case Evaluation.

1. Integrated system operations analysis;
2. Capital and life-cycle cost analysis;
3. Facility siting constraints assessment;
4. Environmental water quality review;
5. Consideration of water treatment impacts; and
6. Permitting and regulatory review.

Because of their overlapping and correlated purposes, the initial Project Viability Assessment and Business Case Evaluation are not separated in this report though the focus of each was slightly different. The purpose of the preliminary Project Viability Assessment was to identify any potential "fatal flaw" to developing an integrated system using the six tasks listed above; a fatal flaw is defined as a condition that would by itself, or when combined with other constraints, present an unavoidable obstacle that would not allow the project to proceed. The purpose of the Business Case Evaluation was to compare the separate, independently adopted water strategies of both TRWD and DWU with integrated raw water delivery system configurations using a Triple Bottom Line approach that compares the economic, environmental, and social impacts.

Several key objectives must be met to complement or replace existing, independent water supply plans:

- An integrated raw water transmission system alternative must enhance the redundancy, flexibility, and demand risk management of the existing water supply systems;
- An interconnected plan must make sufficient water supply available to meet demands where and when needed, under a full range of historical hydrological conditions;
- An integrated raw water transmission system alternative must reduce capital and life-cycle costs, while not contributing to unmitigated treatment or distribution costs for DWU or TRWD customers; and
- All scenarios must fully consider societal, environmental, and regulatory complexities

With these key objectives guiding the way, four project conveyance alternatives were developed by bounding the study (**Figure 1-3**), using a progressive screening approach to evaluate combinations of conveyance infrastructure and interconnections, and then selecting two Baseline Alternatives (independent water strategies) and the two most promising Interconnection Alternatives (integrated delivery systems), as described in **Table 1-1**. The two Baseline Alternatives represent two strategies in consideration by DWU as an independent supply option; both alternatives deliver water from Lake Palestine but differ in the delivery point (Joe Pool Lake or the Southeast Water Treatment Plant). TRWD may consider constructing a "southern pipeline" route from East Texas to Lake Benbrook as an alternative independent supply option to the Third Pipeline but this possibility was not included as a third Baseline Alternative in this analysis.

Additional treatment and water transmission facilities for DWU that may be required for an integrated strategy but were beyond the study boundary (**Figure 1-3**) are considered in Section 8 of this report. **Figure 1-4** through **Figure 1-7** illustrate the four project conveyance alternatives and **Figure 1-8** shows all pipeline routes used in these project alternatives. A description of the components in these water supply systems follows **Figure 1-8**.

Table 1-1
Project Conveyance Alternatives

Alternative	Description
1 (Baseline)	Independent Systems: TRWD's East Texas Third Pipeline and DWU's connection of Lake Palestine to the proposed Southeast Water Treatment Plant
2 (Baseline)	Independent Systems: TRWD's East Texas Third Pipeline and DWU's connection of Lake Palestine to Joe Pool Lake
3 (Interconnection)	Integrated System: Interconnected Third Pipeline (upsized as compared to the baseline condition) with connection of Lake Palestine to Cedar Creek Reservoir and delivery to DWU at Joe Pool Lake and TRWD's customers through the Third Pipeline
4 (Interconnection)	Integrated System: Interconnected "Southern Pipeline" - Lake Palestine delivered to the Lake Benbrook pipeline via a pipeline route to the south of the TRWD Third Pipeline route. Delivery to DWU at Joe Pool Lake and TRWD's customers through connections to the existing system and the Lake Benbrook pipeline.

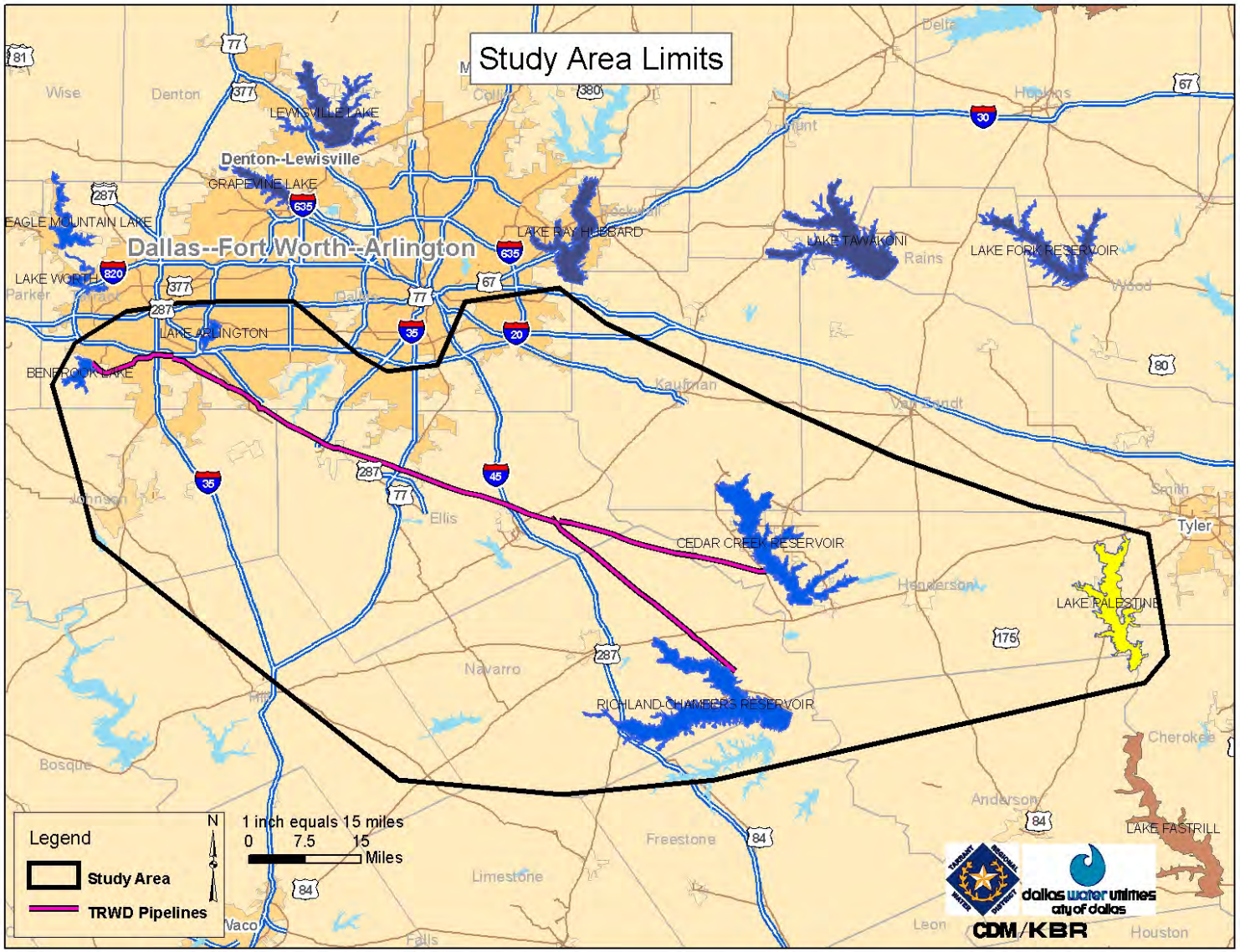
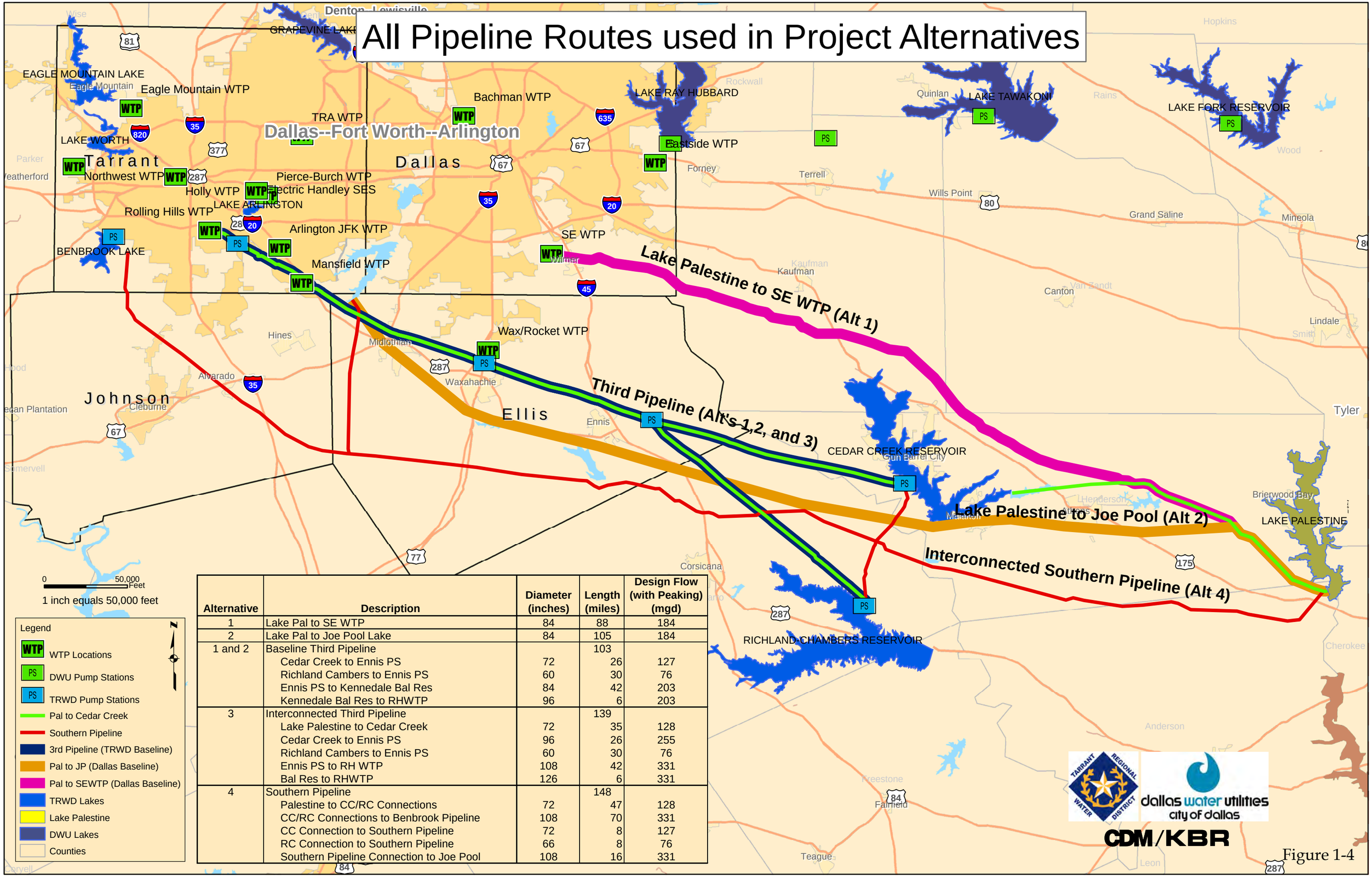


Figure 1-3
Study Area Limits

All Pipeline Routes used in Project Alternatives



0 50,000 Feet

1 inch equals 50,000 feet

Legend

- WTP Locations
- DWU Pump Stations
- TRWD Pump Stations
- Pal to Cedar Creek
- Southern Pipeline
- 3rd Pipeline (TRWD Baseline)
- Pal to JP (Dallas Baseline)
- Pal to SEWTP (Dallas Baseline)
- TRWD Lakes
- Lake Palestine
- DWU Lakes
- Counties

Alternative	Description	Diameter (inches)	Length (miles)	Design Flow (with Peaking) (mgd)
1	Lake Pal to SE WTP	84	88	184
2	Lake Pal to Joe Pool Lake	84	105	184
1 and 2	Baseline Third Pipeline		103	
	Cedar Creek to Ennis PS	72	26	127
	Richland Cambers to Ennis PS	60	30	76
	Ennis PS to Kennedale Bal Res	84	42	203
	Kennedale Bal Res to RHWTP	96	6	203
3	Interconnected Third Pipeline		139	
	Lake Palestine to Cedar Creek	72	35	128
	Cedar Creek to Ennis PS	96	26	255
	Richland Cambers to Ennis PS	60	30	76
	Ennis PS to RH WTP	108	42	331
	Bal Res to RHWTP	126	6	331
4	Southern Pipeline		148	
	Palestine to CC/RC Connections	72	47	128
	CC/RC Connections to Benbrook Pipeline	108	70	331
	CC Connection to Southern Pipeline	72	8	127
	RC Connection to Southern Pipeline	66	8	76
	Southern Pipeline Connection to Joe Pool	108	16	331

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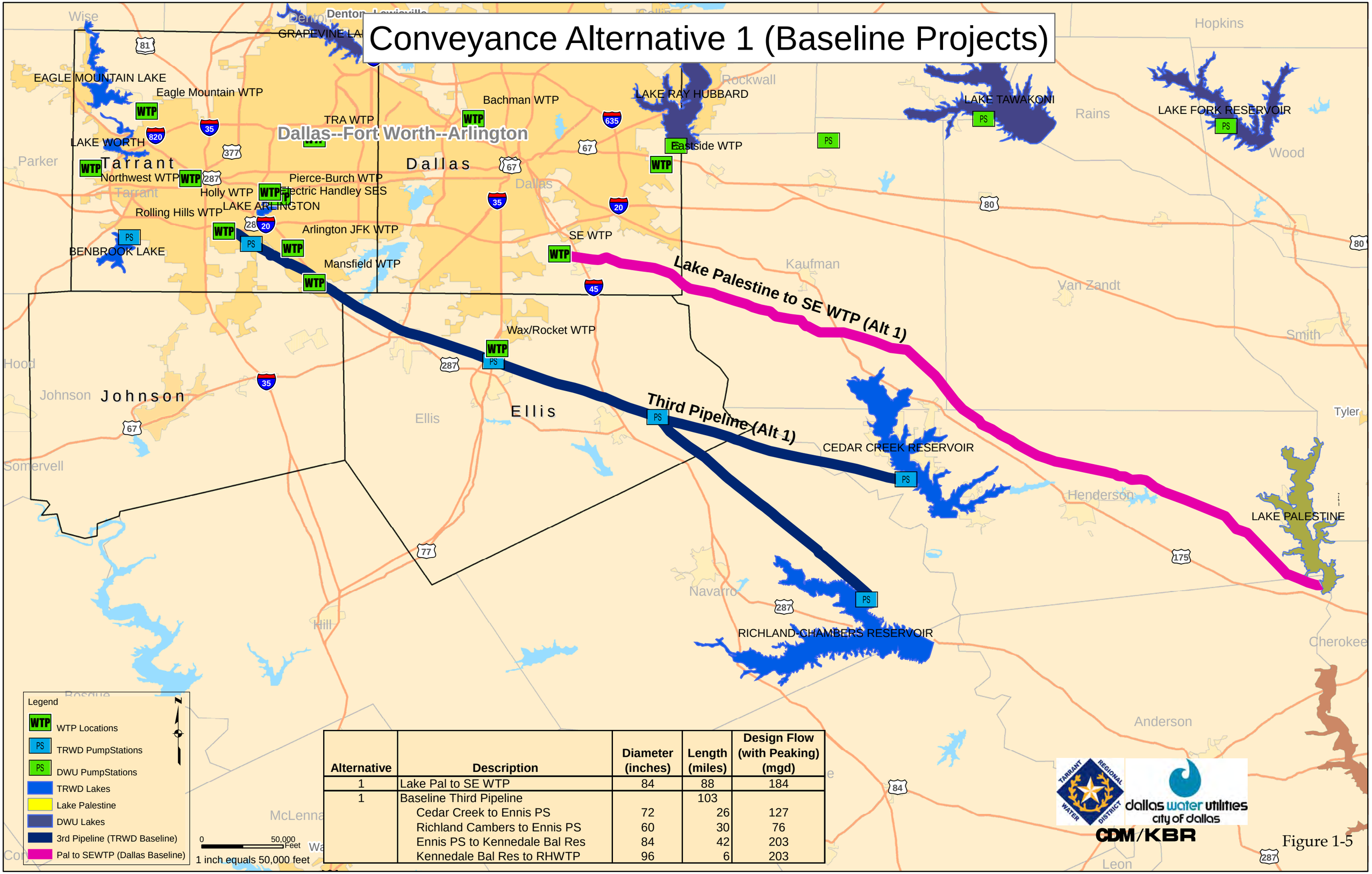
Figure 1-4

Conveyance Alternative 1 (Baseline Projects)



Alternative	Description	Diameter (inches)	Length (miles)	Design Flow (with Peaking) (mgd)
1	Lake Pal to SE WTP	84	88	184
1	Baseline Third Pipeline		103	
	Cedar Creek to Ennis PS	72	26	127
	Richland Cambers to Ennis PS	60	30	76
	Ennis PS to Kennedale Bal Res	84	42	203
	Kennedale Bal Res to RHWTP	96	6	203

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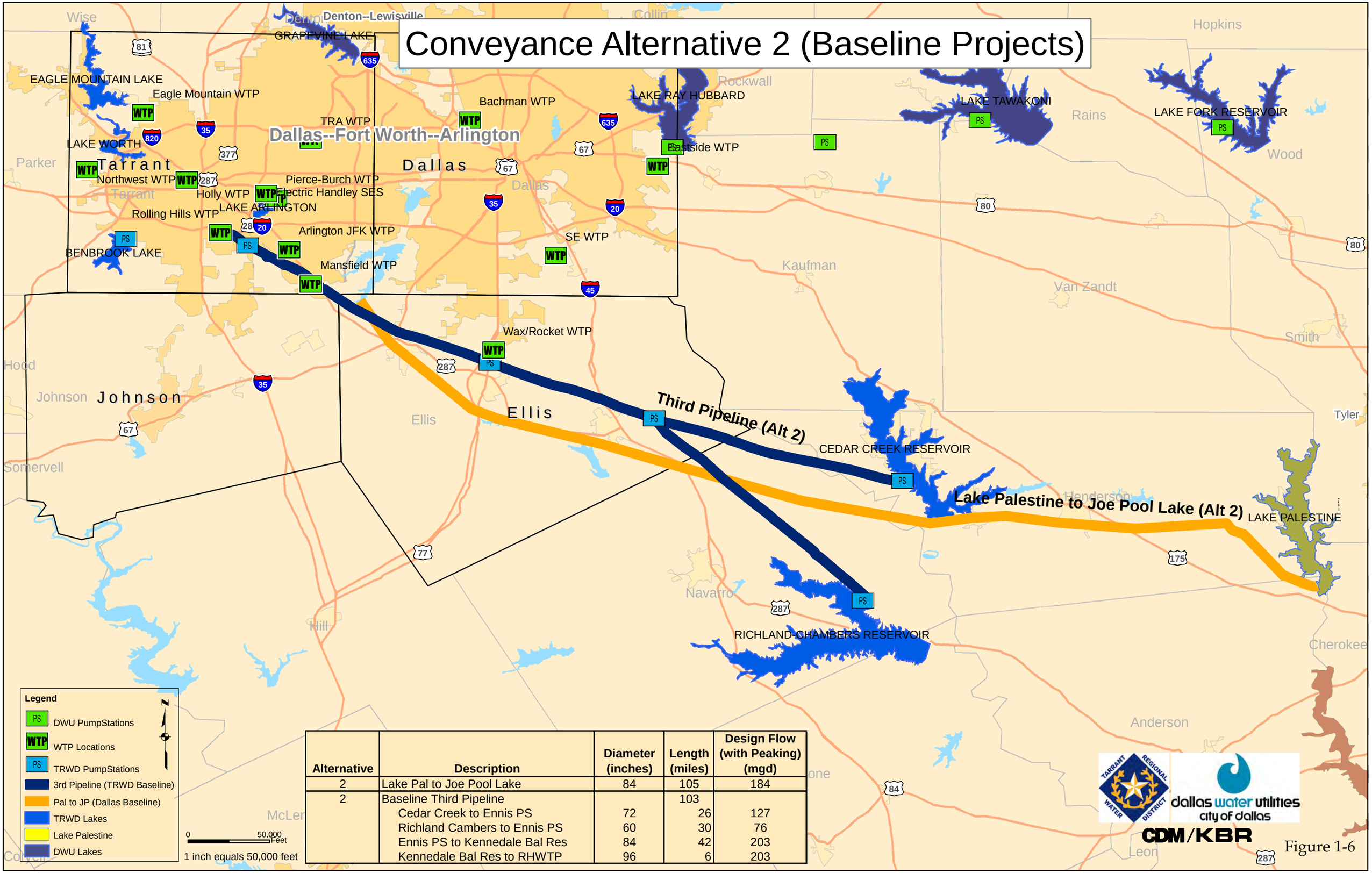
Figure 1-5

Conveyance Alternative 2 (Baseline Projects)



Alternative	Description	Diameter (inches)	Length (miles)	Design Flow (with Peaking) (mgd)
2	Lake Pal to Joe Pool Lake	84	105	184
2	Baseline Third Pipeline		103	
	Cedar Creek to Ennis PS	72	26	127
	Richland Cambers to Ennis PS	60	30	76
	Ennis PS to Kennedale Bal Res	84	42	203
	Kennedale Bal Res to RHWTP	96	6	203

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Figure 1-6

Conveyance Alternative 3 (Interconnected Third Pipeline)

Interconnected Third Pipeline (Alt 3)

Alternative	Description	Diameter (inches)	Length (miles)	Design Flow (with Peaking) (mgd)
3	Interconnected Third Pipeline		139	
	Lake Palestine to Cedar Creek	72	35	128
	Cedar Creek to Ennis PS	96	26	255
	Richland Cambers to Ennis PS	60	30	76
	Ennis PS to RH WTP	108	42	331
	Bal Res to RHWTP	126	6	331

Legend
- WTP Locations
- DWU PumpStations
- TRWD PumpStations
- TRWD Lakes
- Lake Palestine
- DWU Lakes
- Interconnected 3rd Pipeline

0 50,000 Feet
1 inch equals 50,000 feet

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Figure 1-7

Conveyance Alternative 4 (Interconnected Southern Pipeline)

Interconnected Southern Pipeline (Alt 4)

Alternative	Description	Diameter (inches)	Length (miles)	Design Flow (with Peaking) (mgd)
4	Southern Pipeline		148	
	Palestine to CC/RC Connections	72	47	128
	CC/RC Connections to Benbrook Pipeline	108	70	331
	CC Connection to Southern Pipeline	72	8	127
	RC Connection to Southern Pipeline	66	8	76
	Southern Pipeline Connection to Joe Pool	108	16	331

Legend
- DWU PumpStations
- TRWD PumpStations
- WTP Locations
- TRWD Lakes
- Lake Palestine
- DWU Lakes
- Interconnected Southern Pipeline

0 50,000 Feet
1 inch equals 50,000 feet

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Figure 1-8

1.3 System Descriptions

1.3.1 Lake Palestine

Lake Palestine is owned and operated by the Upper Neches River Municipal Water Authority (UNRMWA) and is located in Region I (East Texas Region) approximately 85 miles southeast of Dallas. UNMWA has contracted to supply up to 114,937 acre-feet per year, (average 102 million gallons per day) to Dallas which holds an interbasin transfer permit to the Trinity River Basin. The 2006 Region C Water Plan recommends as a Water Management Strategy (WMS) that Dallas construct the infrastructure to transport this water from Lake Palestine to Dallas because of its relatively low cost and environmental and permitting risk impact.

1.3.2 Proposed Southeast Water Treatment Plant and Joe Pool Lake

The proposed DWU Raw Water Supply System for the Southeast Water Treatment Plant (SEWTP) would convey Lake Palestine and, possibly in the future, Lake Fastrill, Toledo Bend Reservoir, and other East Texas water supplies to the site purchased for the Southeast Water Treatment Plant. Updated planning level cost estimates have been developed for the raw water transmission facilities needed to transport water to this site for Dallas.

Lake Palestine Spillway

Joe Pool Lake is located on Mountain Creek in the Trinity River Basin in both Dallas and Tarrant Counties. This U.S. Army Corps of Engineers (USACE) reservoir has conservation storage of 176,900 acre-feet. The Trinity River Authority (TRA) has a water supply agreement with the Corps of Engineers and holds the water rights for 17,000 acre-feet per year, or 15 mgd average. According to the Texas Commission on Environmental Quality (TCEQ) Trinity River Water Availability Model (WAM), the available water supply from Joe Pool Lake in 2060 will be 10,000 acre-feet per year. For purposes of this investigation, conveyance alternative 2 and both interconnection alternatives deliver water to the Joe Pool Lake vicinity. Currently Joe Pool Lake serves as a public water supply for the City of Midlothian, which has a water intake structure in the southeast leg of the lake. TRA also has a water intake structure in Cedar Hill State Park, but it is not currently in use. Several other entities have a contractual interest in Joe Pool Lake with TRA but are not currently using it as a drinking water supply.

- City of Grand Prairie – 1,795 acre-feet per year for municipal and domestic uses.
- City of Duncanville – 1,197 acre-feet per year for municipal and domestic uses.

- Midlothian Water District – 6,662 acre-feet per year for municipal and domestic uses

- City of Cedar Hill – 7,346 acre-feet per year for municipal and domestic and industrial uses.

1.3.3 TRWD East Texas Supply

Cedar Creek Reservoir is located on Cedar Creek in the Trinity River Basin in Henderson and Kaufman Counties. The reservoir has 678,900 acre-feet of conservation storage. TRWD holds a water right for diversion of 175,000 acre-feet per year (156 mgd average). According to the TCEQ Trinity River WAM, the available safe yield (synonymous to firm yield except reservoir is left with one year of storage at the end of the critical drought as opposed to zero storage) from Cedar Creek in 2060 will be 175,000 acre-feet per year. TRWD conveys water from Cedar Creek Reservoir through an existing pipeline and will increase conveyance capacity with the proposed Third Pipeline to convey the full 175,000 acre-feet per year and an additional 52,500 acre-feet per year from the Trinity River constructed wetlands.

Richland-Chambers Reservoir is located on Richland and Chambers Creeks in the Trinity River Basin in Freestone and Navarro Counties. The reservoir has 1,135,000 acre-feet of conservation storage. TRWD and the City of Corsicana hold combined water rights in the reservoir totaling 223,650 acre-feet per year with TRWD holding 210,000 acre-feet per year (187 mgd average). According to the TCEQ Trinity River WAM results, the available safe yield from Richland-Chambers will decrease by approximately 35,300 acre-feet per year from 2010 to 2060. However, TRWD analysis has shown that sedimentation rates currently projected in the Texas regional planning models are overstated and that actual rates will have a negligible effect on the safe yield. TRWD conveys supply from Richland-Chambers Reservoir through an existing pipeline and will increase conveyance capacity with the proposed Third Pipeline to convey the full 210,000 acre-feet per year and an additional 63,000 acre-feet per year from the Trinity River constructed wetlands.

The system also includes Lake Arlington, owned by the City of Arlington and ExTx LaPorte, and Lake Benbrook owned by the Corps of Engineers with TRWD holding a contract with USACE and a TCEQ water right permit. Both of these reservoirs provide terminal storage for the District's customers with relatively small yields from upstream runoff. Lake Benbrook is located on the Clear Fork of the Trinity River in Tarrant County and has conservation storage of 72,500 acre-feet; TRWD has a maximum overdraft diversion of 72,500 acre-feet per year on a non-priority basis. Lake Arlington, also in Tarrant County, is located on Village Creek and has 45,710 acre-feet of conservation storage. These terminal storage reservoirs primarily receive waters pumped from Richland-Chambers or Cedar Creek Reservoirs.

The Tarrant Regional Water District also has received a water rights permit from the Texas Commission on Environmental Quality allowing the diversion of return flows of treated wastewater from the Trinity River. TRWD has plans to pump the return

flows from the Trinity River into constructed wetlands and then into Richland-Chambers Reservoir and Cedar Creek Reservoir. This project will provide an additional 115,500 acre-feet per year of new supply. The Region C Plan recommends this relatively inexpensive source of water and the associated raw water delivery facilities of a third pipeline as a preferred water management strategy. For purposes of this study, both the constructed wetlands at the two reservoirs and all the additional conveyance facilities to deliver the constructed wetlands water supply to Richland-Chambers and Cedar Creek Reservoirs are assumed to be complete and in use by 2020.

1.3.4 TRWD West Fork Supply

The West Fork Trinity River portion of TRWD's system includes Lake Bridgeport and Eagle Mountain Lake owned and operated by the District, and Lake Worth owned by the City of Fort Worth. Water from the West Fork of the Trinity River Basin flows by gravity from Lake Bridgeport into Eagle Mountain Lake and then on to Lake Worth. In May 2008 the District completed its Eagle Mountain Connection Project which includes pipelines, pump stations and other facilities to interconnect the District's eastern and western supplies. Through this project, water from Cedar Creek and Richland-Chambers Reservoirs is conveyed to Eagle Mountain Lake.

The volume and rate of water delivered to Eagle Mountain Lake through the Eagle Mountain Connection was included in the modeling. No detailed modeling of the West Fork supply was included in this analysis because integration of the raw water system will not affect the West Fork – it acts as an external demand or supply to the integrated system but it is not requisite to model the disaggregated West Fork supplies in this study.

1.4 Assumptions and Limitations

As described in Section 1.2, the purpose of this initial Project Viability Assessment was to identify any potential "fatal flaw" to developing an integrated system and the purpose of the Business Case Evaluation was to compare the separate, independently adopted water strategies of both TRWD and DWU with integrated raw water delivery system configurations. This is therefore a preliminary, fatal-flaw level analysis with inherent limitations and risk factors. This section captures the principle assumptions and limitations in the six project analyses.

1.4.1 Integrated Operations Analysis

To examine some of the principal differences between routing water from Lake Palestine directly to DWU's terminal points and routing it through new and existing TRWD infrastructure, an integrated system operations model was developed. The model is neither a comprehensive hydraulic model nor a prescriptive day-to-day operations model. *The results from the optimization program should not be construed as a prescriptive approach for future operations, but rather, as a simple means of bounding the theoretical performance of the conveyance alternatives.*

- Operations costs consider only the energy cost in the conveyance system. Routine operations and maintenance is not included and treatment costs are also excluded.

- No adjustments were made to apply downstream release requirements that were not explicitly included in the RiverWare model.

- This optimization model is not intended to function as a hydraulic model. It is intended to provide an understanding of basic delivery requirements necessary to identify energy needs and costs associated with moving water through the system. Calculations for head requirements (elevation and line losses) were conducted outside of the model and these relationships were imported in simplified form so that movement of water incurs costs on a relative basis throughout the system.

- All scenarios for independent and joint water management were predicated on the assumption that DWU requires the full yield from Lake Palestine (102 mgd) in all future years. This assumption was held constant even if some of the 102 mgd could originate from TRWD water sources in an interconnected system. This assumption was adopted for comparative purposes, and to limit the number of potential scenarios in this fatal flaw analysis by bracketing the results. Though other scenarios with varying DWU demand on Lake Palestine water will provide enhanced detail, the fundamental question of the potential opportunities for benefits through integration is captured with this assumption and additional detail will not create results outside of the limits imposed by this assumption.

1.4.2 Capital and Life-Cycle Cost Analysis

The purpose of the cost analysis task was to develop a screening level/conceptual opinion of probable capital and lifecycle cost for each project conveyance alternative and to conduct a present worth economic comparison between the Baseline and Interconnection alternatives. The cost analyses represent total costs for water delivery and do not allocate costs between DWU and TRWD. The capital cost opinions presented herein are based on guidelines established by the Texas Water Development Board (TWDB) for use in regional water planning activities.

These cost opinions are roughly equivalent to a screening- or feasibility-level Class 4 to Class 5 estimate (per AACEI International Recommended Practice No. 17R-97, as shown in **Figure 1-9**).

Spreadsheet cost models were developed to aid in the formulation of a conceptual opinion of probable capital cost for each project scenario. These cost models incorporate planning level engineering design assumptions and a contingency appropriate to this early phase of project definition and development and in consideration of the limited availability of site-specific data.

Capital cost estimates derived from TWDB guidelines for regional water planning include assumptions and inherent uncertainties that may introduce significant

inaccuracies into the analysis. These assumptions and uncertainties will be revisited and refined through subsequent phases of project definition and development. Key assumptions and uncertainties include:

1. The analysis does not include detailed cost engineering to determine probable material and labor costs at the time of construction, possibly five or more years into the future. Unit costs are based on updates from 2002 levels to 2006 levels, prepared by Region C for incorporation into the 2011 water plan. These 2002 cost levels are currently shown in tables in Appendix U of the 2006 Region C Water Plan. For this analysis, Engineering News Record (ENR) cost indexes and U.S. Bureau of Labor Statistics data (Producer Price Index, Material Price Index) were used to escalate the unit costs of pipelines and pump stations, the two largest cost components of each project scenario, from 2006 to 2008.

2. Costs associated with the closure, mitigation and/or relocation of oil and gas wells, environmental mitigation, relocations of existing infrastructure, and other similar design issues cannot be accurately estimated at this stage of project definition and development.

	Primary Characteristic	*Secondary Characteristic*			
ESTIMATE CLASS	LEVEL OF PROJECT DEFINITION Expressed as % of complete definition	END USAGE Typical purpose of estimate	METHODOLOGY Typical estimating method	EXPECTED ACCURACY RANGE Typical +/- range relative to best index of 1 [a]	PREPARATION EFFORT Typical degree of effort relative to least cost of index 1 [b]
Class 5	0% to 2%	Screening or Feasibility	Stochastic or Judgment	4 to 20	1
Class 4	1% to 15%	Concept Study or Feasibility	Primary Stochastic	3 to 12	2 to 4
Class 3	10% to 40%	Budget, Authorization or Control	Mixed, but Primarily Stochastic	2 to 6	3 to 10
Class 2	30% to 70%	Control or Bid/Tender	Primarily Deterministic	1 to 3	5 to 20
Class 1	50% to 100%	Check Estimate or Bid/Tender	Deterministic	1	10 to 100

Notes: [a] If the range index of value "1" represents +10/5%, then an index value of 10 represents +100/-50%
[b] if the cost index value of "1" represents 0.005% of project costs, then an index value of 100 represents 0.5%.

Figure 1-9
Association for the Advancement of Cost Engineering,
Recommended Practice 17R-97; Cost Estimating Classification System

3. Real estate acquisition costs and issues cannot be evaluated at this stage of project development and will undoubtedly impact project cost estimates. In addition to uncertainties regarding the cost of real estate acquisition, capital cost estimates for each project alternative could be impacted if real estate issues dictate transmission system alignments that are longer or are at higher elevations, or both. A more detailed analysis of alternative pipeline alignments will be performed in a subsequent phase of project development. Rates of $3,000 per acre of permanent easement and $1,500 per acre of temporary easement were used (per Region C guidelines).

4. Per direction received in Workshop 1, additional conveyance capacity to accommodate future supply sources to the east was not included in the conceptual design of these systems. Instead, it was assumed that the cost of easements will include right-of-way for pipelines in the project scenarios of this study and additional right-of-way sufficient for one additional pipeline of equal dimensions.

5. In alternatives utilizing the Third Pipeline route, it may be possible to upgrade or expand existing pump stations to accommodate additional capacity. In this analysis, these cost savings were not accounted for in an effort to be conservative.

1.4.3 Future Capital and Life-Cycle Cost Analysis

The purpose of the capital and life cycle cost analysis was to provide preliminary data to allow the sponsors, DWU and TRWD, to make an informed decision as to whether to proceed with further definition and development of a project to integrate water transmission facilities to deliver raw water from Lake Palestine and the TRWD East Texas system. Because of the high-level nature of the analysis, the capital cost estimates and lifecycle cost analyses will need to be refined and updated in subsequent phases of project definition and development. Also, additional analysis will provide more information to differentiate between interconnection alternatives and between baseline and interconnection alternatives. Recommended refinements in the cost analysis are:

- Though phasing opportunities are discussed in section 2 of this report, phasing is not addressed in the cost analyses. However, it could have significant impacts on lifecycle costs, potentially increasing the cost differential between the Baseline and Interconnection scenarios. Specifically, phasing could result in significant reduction of costs associated with the Interconnected Southern Pipeline due to the potential to defer development of transmission facilities required to deliver water to Lake Benbrook. Though phasing could be a proportionally larger benefit in terms of the life cycle costs of the Southern Pipeline, the purpose of this investigation was not to identify a preferred alternative but rather to compare Baseline and Interconnected project scenarios.

- The location of booster and intake pump stations will impact the cost of electricity inasmuch as those facilities could be served by suppliers with lower or higher rates. However, because these locations will likely change on the order of many miles, the energy provider used in this analysis (based on conceptual siting) may change in subsequent phases and updates to cost analyses should include more specific energy cost data as it becomes available.

- Refinements and updates to the capital cost modeling should occur as specific alignments are selected and as the design of facilities progresses.

- These cost analyses represent total costs for water delivery and do not attempt to allocate costs to DWU and TRWD systems. Subsequent phases in this feasibility assessment will address cost and gain sharing.

1.4.4 Constraints Analysis

A preliminary facility siting constraints analysis was performed to identify potential fatal flaws to locating water transmission facilities along select pipeline corridors and to make a comparison between project conveyance alternatives. The preliminary constraints analysis was accomplished using publicly available data from secondary sources with no field data collection. Because additional site-specific data and more detailed analysis will be required in subsequent phases to fully assess potential constraints and impacts, the "opinion of probable impact" will likely be modified as additional data is acquired and pipeline alignments are refined.

The primary components of each of the project conveyance alternatives are transmission pipelines. Though intakes and booster pump stations are also required, the location of these facilities is at a conceptual, approximate level. Because these locations will likely change on the order of many miles throughout the planning and design phases, analyzing constraints to siting pumping facilities was not appropriate at this stage and is reserved for future phases when these locations are less subject to change.

The preliminary findings of the constraints analysis are contained in the Alternatives Evaluation Matrix (AEM), with an analysis of each evaluation criterion and component, and an impact rating for each evaluation criterion. The evaluation is qualitative and will be modified and enhanced as additional data become available and as engineering analyses progress in subsequent phases of project definition and development. It should be noted that the ratings developed in this analysis do not consider several factors, although these factors will be evaluated during subsequent phases:

- Construction schedule;

- Permitting requirements;

- Political favorability;

- Land ownership (data not yet available);
- Operations and Maintenance considerations (beyond cost, which is included in the lifecycle cost analysis); and
- System compatibility and operations.

1.4.5 Environmental Water Quality and Water Treatment Considerations

The purpose of the environmental water quality review was to determine impacts on receiving water quality by the introduction of Lake Palestine water under varying conditions into Lake Benbrook, Cedar Creek Reservoir, Richland-Chambers Reservoir, and Joe Pool Lake. The water quality review included data collection and analysis, mass balance calculations, and a water quality evaluation.

Atrazine data was not available in Lake Palestine or Cedar Creek Reservoir and bromide data was not available in Joe Pool Lake. The majority of the bromide data for Lake Benbrook, Cedar Creek Reservoir, and Richland-Chambers Reservoir included reported values with numerous detection limits. The detection limits were not consistent from reservoir to reservoir and were much higher than the suspected actual concentration. Accordingly, the bromide data were not utilized as part of this environmental water quality evaluation due to the inconsistency of the testing protocols and concerns about the integrity of the available reported data.

The results of this water quality analysis were based on a mass balance of water from Lake Palestine and the receiving reservoir. While this evaluation can provide information that is useful in a planning context by analyzing the broad impacts of blending water from Lake Palestine with the different reservoirs, a more comprehensive analysis should be conducted to provide the level of detail needed for final decision making purposes. The development of hydrodynamic and water quality models would provide the level of detail needed to predict the specific impact on the receiving reservoir.

As noted in the 2006 Region C Water Plan, in general, East Texas reservoirs such as Lake Palestine have higher concentrations of nutrients than the evaluated receiving reservoirs. The ultimate impact of the imported Lake Palestine water with its higher nutrient concentrations is difficult to predict in this evaluation due to the complex kinetic relationships between nutrients and chlorophyll-a. It should be noted, however, that in the Region C Water Plan all of the water management strategies involving importation of water from East Texas were considered to have “low” or medium-low” impacts on the key water quality parameters.

Section 2
Integrated Operations

2.1 Purpose

The purpose of this analysis was to identify opportunities for benefits, or potential disadvantages, to both TRWD and DWU through integrated operations of the raw water transmission systems from Lake Palestine, Richland-Chambers Reservoir, and Cedar Creek Reservoir. This comparison of Baseline Alternatives 1 and 2 with Interconnection Alternatives 3 and 4 (see **Table 1-1**) was driven by a system operations model and the team's water resource planning experience. This model was formulated as a decision-support system that permitted the user to create an array of scenarios that help answer a series of primary and secondary questions, formulated jointly by the project participants during workshops:

Primary Questions

- Can an integrated system offer the same **supply reliability** and an opportunity to lower **operational costs**?
- Are there potential opportunities for **shared water**, and therefore demand risk management**,** in addition to shared conveyance infrastructure?
- Is there an opportunity for greater **redundancy** (and therefore cost and operational risk management) through more **flexibility** in flow pathways and connectivity to multiple sources?

Secondary Questions

- How might the integration of the two systems affect the **timing** needs for various flow pathways and source connections?
- Could **more water** be made available through an interconnected system than through two independent systems?
- What opportunities for **regional cooperation** are made possible by integrated operations?

The modeling team isolated components of the two supply systems that would be most directly affected by the two programmatic alternatives (Baseline or Interconnection) and created an array of scenarios that bounded the opportunities for benefits to both TRWD and DWU. In other words, scenarios were selected to bracket results with an upper and lower bound so that any additional refinements to this analysis will produce results that fall within the bounds identified here. Using these analyses and the team's water resources planning experience, advantages and disadvantages to interconnection were identified in terms of **operational costs** (see Section 3 for capital and lifecycle cost analyses)**, water sharing and timing,**

redundancy, flexibility, and regional cooperation. The following sections describe the modeling approach and conclusions drawn from this analysis.

2.2 Modeling Approach

A detailed modeling plan memorandum was developed in November 2007. This section is intended to provide an overview of the final modeling approach, which followed the original plan with minor adjustments, by briefly discussing tools, techniques, and guidelines. In this way, the results can be understood in their appropriate context.

To isolate components of the two supply systems that would be most directly affected by the two programmatic alternatives (Baseline or Interconnection), and to avoid unnecessary detail associated with subsystems less directly affected, the system was bounded as shown in **Figure 2-1** for modeling purposes. Because not every DWU and TRWD demand node is included in the model, total water user group demand was apportioned between model nodes in the following way:

- **DWU**: The total demand on the modeled system, at either Joe Pool Lake or the Southeast WTP, was Dallas' contracted amount from Lake Palestine, 102 mgd. This isolated the direct impacts of Dallas demand on the conveyance alternatives.

- **TRWD**: Projected demands at each node were extracted from the RiverWare model. To approximate the demand from external nodes on water within the modeled system, the TRWD RiverWare model was used to simulate the West Fork system. These external node demands are initially satisfied by water originating in the West Fork. Water from the modeled system is also delivered to Eagle Mountain Lake.

  West Fork supply is capped by a contractual limitation for normal and drought conditions applicable to the City of Fort Worth. Demand in the West Fork that is not satisfied by West Fork flows is supplied from the bounded system in the optimization model. Water to satisfy monthly targets in Lake Arlington, as well as maintaining minimum conservation pool level at Lake Benbrook; also implicitly represent an internal demand on system water.

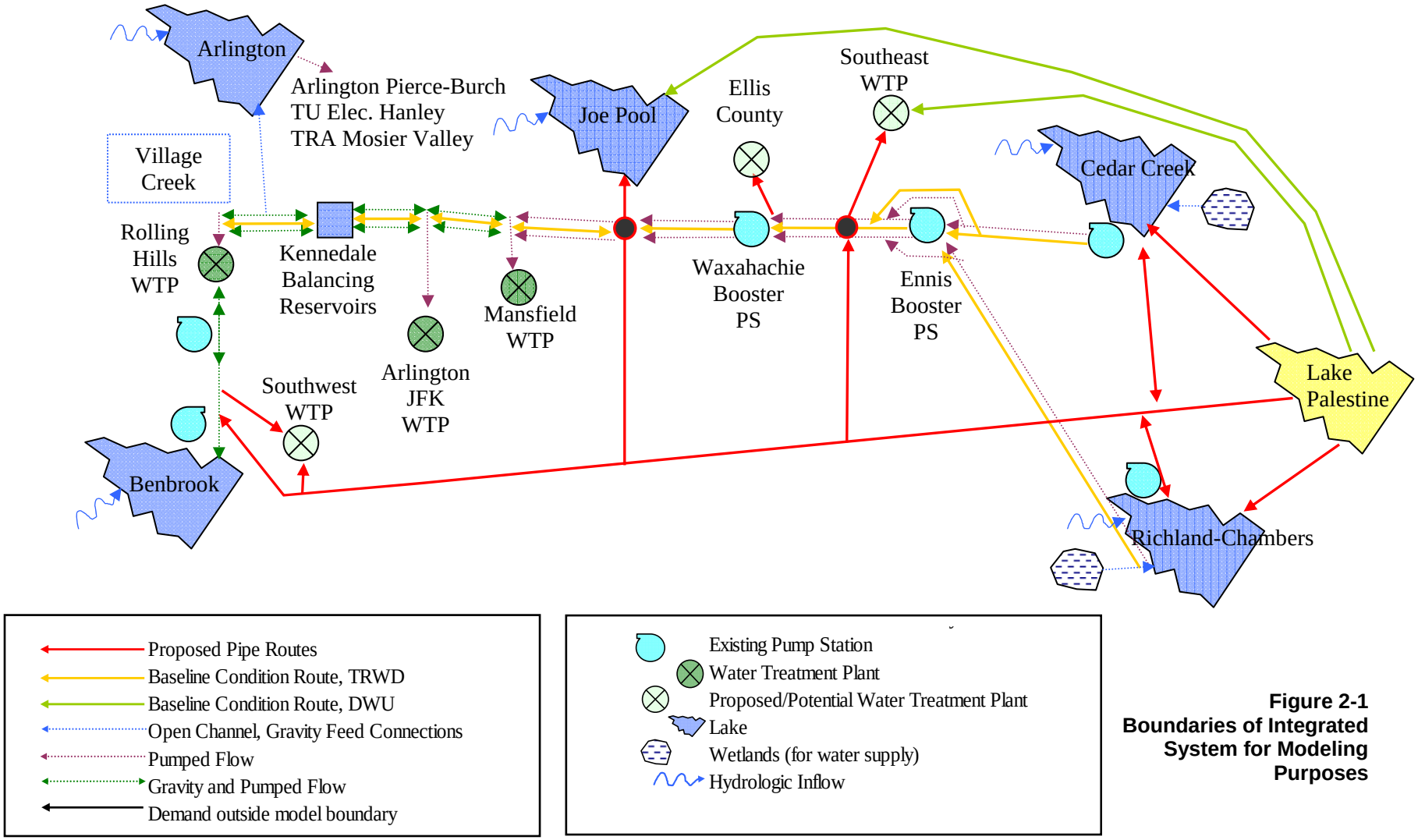


Figure 2-1
Boundaries of Integrated System for Modeling Purposes

- **Ellis County**: Projected demands for Ellis County were based on a combination of Region C 2006 Water Plan projections and the current Region C Four County Study conducted by Freese & Nichols, Inc. These demands were supplied by water available in the bounded system (generally TRWD water in the modeled scenarios).

In addition to the existing infrastructure within its boundaries, the model also included certain TRWD projects that are in the development or construction phase, or have a high probability of being constructed. These included the planned constructed wetlands at Richland-Chambers and Cedar Creek Reservoirs, the recently completed Eagle Mountain Connection from the Rolling Hills Pump Station, and the future Fort Worth Southwest Water Treatment Plant.

In general, the model was formulated on three basic tenets, described in more detail in the sections below:

- Water distribution priorities and cost calculations establish a basis for **comparison**, **not allocation** between the two entities.
- The model was formulated to focus on opportunities and costs.
- Existing operating rules were suspended (except as discussed in section 2.2.3) and the optimization program was used to suggest effective operational practices and priorities.
- The model relied on existing data sources and models (such as TRWD's RiverWare model).

2.2.1 Water Distribution and Cost Calculations

Because the purpose of this modeling was to compare Baseline and Interconnected scenarios, modeling protocols were established to provide commonality between scenarios. These protocols did not represent actual operating agreements or allocate operational costs to individual entities. Instead, they established priorities for water distribution so that the modelers could experiment with the potential for water sharing and operational cost reduction. Results indicate opportunities, not designs.

A primary modeling protocol related to demand and the distribution of water. In Baseline scenarios (independent systems), DWU's demand and allocation from Lake Palestine were 102 mgd at all times and there was no access to TRWD supplies; though the supply reliability of the DWU raw water delivery system will decrease over time as additional water supplies are required, the overall Dallas system was not modeled (in order to emphasize the elements most directly affected by interconnection) and only the 102 mgd from Lake Palestine was included. In a Baseline scenario therefore, DWU always received 102 mgd and the model was used to optimize operating costs. In the Baseline TRWD scenario, it had sole access to its

supplies and the model considered the entire TRWD system (portions of which are only external demands to the pieces modeled in detail). The model was therefore used to calculate operating costs and supply reliability decreases over time as additional water supplies are required.

In Interconnected modeling scenarios, the model considered the potential for water delivery from Lake Palestine or any portion of the TRWD system to be the same. The purpose of the model was to therefore explore the potential for cost savings, redundancy, water sharing, and etc. by optimizing in a two-step process – first the reliability of deliveries to TRWD and DWU, and second optimizing the operational costs of that "highest reliability" run by iterating on alternative delivery pathways.

The first step required "prioritization" of deliveries to three entities: TRWD, DWU, and Ellis County. Because interconnection presents no advantage to DWU if it can no longer access the 102 mgd available in an independent system, the model ensured delivery of the full 102 mgd to DWU. This also assumes that the DWU demand does not gradually increase but rather is the entire 102 mgd from Lake Palestine. Because interconnection presents no advantage to TRWD if supply reliability is lower in an integrated system than an independent system, the model then optimized TRWD's reliability, which will still decrease over time because additional water supplies were not added to the model at the decade they are required in the future; the purpose was therefore to ensure that the hydraulic capacity is available to at least match the reliability it would produce under baseline conditions, not to ensure 100% reliability in the future. After these two supplies were optimized, the model allocated additional water supplies to Ellis County.

2.2.2 Primary Focus on Opportunities and Costs

The model was formulated to help identify opportunities for operational cost savings (see Section 3for capital and lifecycle cost analyses), water sharing and timing, redundancy, flexibility, and regional cooperation associated with an interconnected system. To fully explore the potential for such a system, most existing operating rules were suspended and the model employed an optimization program to route water through the system segments in a manner that would minimize deficits at demand nodes, and to do so at the lowest estimated operating costs. The system was constrained by pipeline capacities, reservoir storage, and water availability, and conveyance costs were computed on a monthly basis for each reach in the system (as shown in **Figure 2-1**).[1]

2.2.3 Simplified Operating Rules

The optimization program was used to suggest effective operational practices and priorities (such as when to draw from Lake Palestine, for example). Though the operating rules of the existing system were not enforced[2], the following operating

[1] See section 1.4.1 for limitations to the integrated operations model.
[2] This was done to avoid the potentially artificial restrictions of applying existing operating protocols to an integrated system that as yet does not exist.

rules were used in an effort to maintain general continuity with well-established existing protocols:

- Flow between points connected by more than one pipeline was divided equally between the pipes (on a capacity percentage basis).
- Existing conservation pool limits were enforced.
- Monthly minimum targets elevations for Lake Arlington were enforced. (540 feet from June- September, 535 feet October – May). Other reservoirs were operated within their specified conservation pools. These targets were found to have only a minimal influence on overall results.
- The model allowed scenarios to be formulated with or without the existing permitted yield constraints on Cedar Creek, Richland-Chambers, and Benbrook Reservoirs (these constraints accounted for contributions from proposed TRWD wetlands to Richland-Chambers and Cedar Creek Reservoirs). Pass-through water from Lake Palestine was also added to existing permitted yield constraints for Richland-Chambers and Cedar Creek where applicable. TRWD indicated that sedimentation rates projected in the Region C planning process for TRWD reservoirs appear to be overstated and actual rates will have a negligible effect on yield. As a result, sedimentation in the reservoirs was not accounted for in the optimization model.
- Holly WTP and Eagle Mountain WTP were supplied water from both the modeled East Texas system and the West Fork Trinity River. The City of Fort Worth, by special conditions in their water rights, was limited to take no more than 100,000 acre-feet per year from the West Fork. During drought conditions, defined as when the West Fork reservoirs (Lake Bridgeport, Lake Worth, and Eagle Mountain Lake) are at less than 50% capacity, the limit was reduced to no more than 46,000 acre-feet per year. These limits were enforced within the model by exporting the demand delivered by the West Fork to each WTP from the RiverWare model, then applying the remainder of the total projected demand for each WTP to the appropriate node in the model.

2.2.4 Reliance on Existing Models

Monthly demand values for each TRWD node within the model were extracted directly from the existing TRWD RiverWare model. Likewise, the hydrologic inflows to each reservoir within the bounded system were extracted directly from RiverWare. Because the DWU demand is bounded by the Lake Palestine yield, no additional data was required from an existing DWU system model.

2.3 Array of Operational Scenarios

The model allowed the formulation of a variety of scenarios, as shown on the screen capture of the model's interface screen in **Figure 2-2**. Various segments of the conveyance infrastructure were activated or deactivated for each scenario, allowing

the model to examine how best to utilize each pathway, and which ones would likely be most cost effective. Each scenario spanned a seven-year period on a monthly timestep and water availability was selected to represent comparatively normal conditions, or the drought of record. Hydrology was superimposed on future demand projections for TRWD and DWU through 2060.

The nearly endless array of possible scenarios was limited to those that clearly provided decision support regarding advantages or disadvantages of investing in infrastructure jointly or separately. These scenarios revealed opportunities for operational cost reductions, water sharing and timing, redundancy, and flexibility. These opportunities were tested for two conditions imposed on the model: permitted yield constrained and system operations. In the permitted yield constraint models (somewhat akin to a "firm yield" condition), the system is limited by conveyance capacity and all water supplies are limited by the lesser of their contracted/permitted amounts or firm yield amounts as defined by TCEQ. In the system operations condition, the model was constrained by lake levels, conveyance capacity and climate, but not by contracted/permitted values.

The following list explains the primary variables used to formulate each scenario:

- Conveyance Alternative: the four conveyance alternatives in **Table 1-1** were used to distinguish costs and benefits between baseline and interconnected alternatives.

- Optimization Objectives: Most scenarios were optimized to yield the highest supply reliability, and then, using those reliability targets, optimized to yield the lowest operational cost. In some experimental scenarios, the model was not optimized for cost because it did not contribute information needed to make decisions based on those particular scenarios.

- To test the impact of the TRWD constructed wetlands, capacity was set to full permitted amounts or zero.

- DWU demand: in experimental scenarios used to test the potential for water sharing, the DWU demand was prioritized behind TRWD and Ellis County and set at 1,000 mgd (essentially unlimited) and set at 0 mgd to test water sharing potential for TRWD.

- Application of existing permitted supply constraints. The model allowed scenarios to be formulated with or without the existing permitted yield constraints on Cedar Creek, Richland-Chambers, and Benbrook Reservoirs.

- Demands could be set by decade between 2010 and 2060.

- Hydrologic Condition: Each alternative could be tested during drought or normal hydrologic conditions.

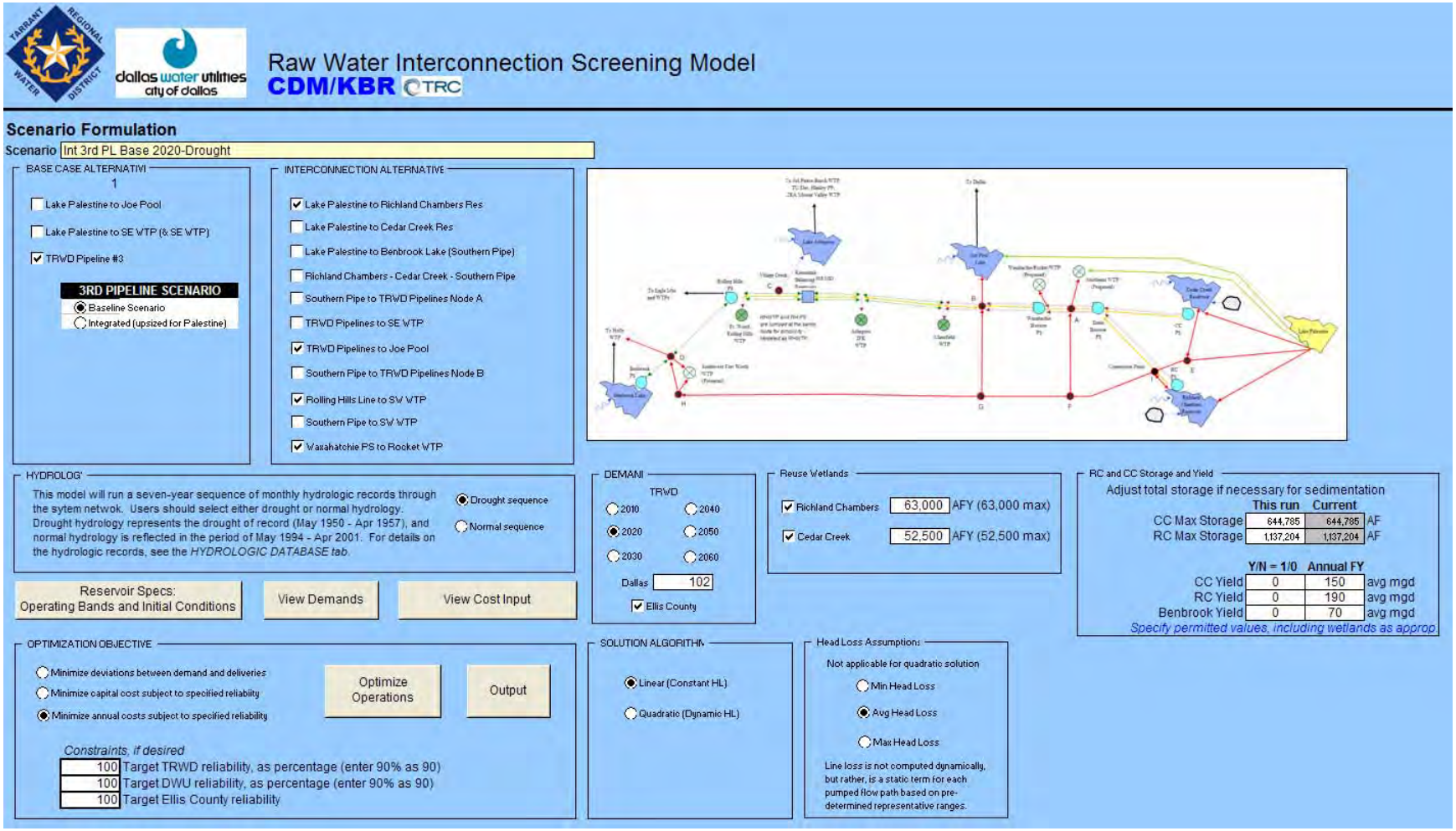


Figure 2-2
Scenario Formulation Interface

2.4 Conclusions from Integrated Operations Analysis

The purpose of this analysis was to identify opportunities for benefits, or potential disadvantages, to both TRWD and DWU through integrated operations of the raw water transmission systems from Lake Palestine, Richland-Chambers Reservoir, and Cedar Creek Reservoir. This comparison of Baseline Alternatives 1 and 2 with Interconnection Alternatives 3 and 4 (see **Table 1-1**) was driven by a system operations model and the team's water resource planning experience. This model was formulated as a decision-support system that permitted the user to create an array of scenarios that help answer a series of primary and secondary questions, formulated jointly by the project participants during workshops:

In this context, we can conclude the following regarding operating costs, water sharing and timing, redundancy, flexibility, and regional cooperation:

2.4.1 Operating Costs

As illustrated in **Figure 2-3**, the integrated operations modeling shows that operating costs within the bounded system (see **Figure 2-1**) are lower in interconnected alternatives as compared to baseline alternatives. This opportunity for operational cost savings is more pronounced in the near term and decreases over time as the difference between interconnected and independent operations is minimized. This near-term savings is attributed to the fact that the full amount of DWU water supply from Lake Palestine is not required immediately. (DWU access to the TRWD supply system could extend the need to connect the Lake Palestine supply to each system.)

2.4.2 Water Sharing and Timing

The integrated operations modeling found that there is opportunity to make extra water available to water user groups via an interconnected system. The analysis suggests that even under drought conditions in 2020, approximately 80 additional mgd could be available. This result is based on three modeling protocols: 1) water availability is limited by existing TRWD permits (for Richland-Chambers, Cedar Creek, and the planned wetlands); 2) DWU demand is equal to the contracted amount in Lake Palestine (102 mgd); and 3) conveyance is limited by the capacity of existing and planned TRWD conveyance facilities.

This result also confirms that Lake Palestine supply will be required prior to 2020 if the DWU demand reaches 102 mgd (though not all of it will be required immediately and dependence upon it as a source could conceivably be phased). Additions to conveyance capacity could be phased through 2030. TRWD requires water supply in addition to sources already included in the model, such as the reuse wetlands, between 2030 and 2040 (based on existing permit constraints and projected demands).

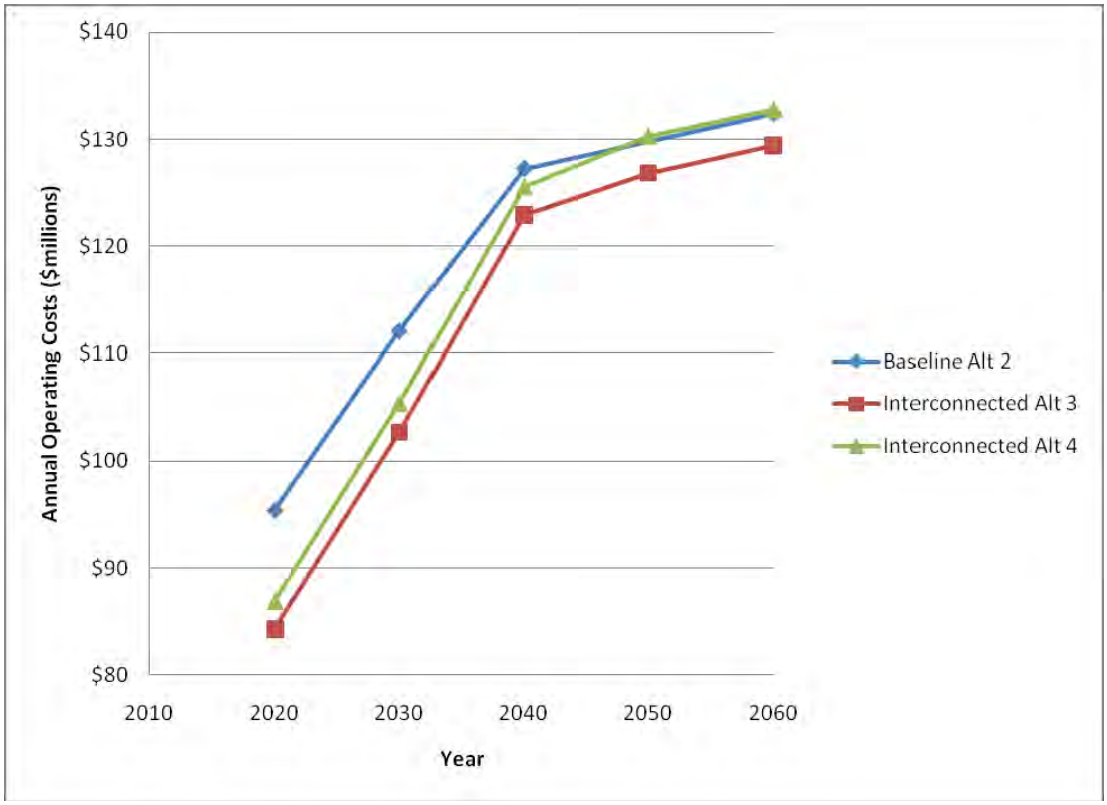


Figure 2-3
Summary of Operational Cost Opportunities Under Drought Conditions

Interconnection also provides the opportunity for TRWD to use the 102 mgd from Lake Palestine. This water sharing may be useful in an emergency situation or in a localized drought condition that causes deficit in the TRWD system while excess is available to DWU. This opportunity to share water between the two water providers is also a method of demand risk management to mitigate the effects of unforeseen demand growth patterns in the TRWD or DWU systems.

By the year 2030, any configuration of the system becomes supply limited, and reliability predictions during severe droughts would be roughly equivalent among configurations. However, during normal hydrologic periods, extra supply is available through 2060 in an interconnected system, though TRWD may have conveyance limitations to accessing the water. The analysis also indicates that the TRWD system can support sustained withdrawals above the current permitted levels. In other words, supply is limited by the permitted amounts, not water availability.

With an interconnected system, any additional water above projected demands would conceivably be available to any water user group, provided that conveyance capacity would be adequate. With separate systems, this water would not be available to DWU and TRWD and its customers would not benefit from potential sales or trades of water above projected TRWD customer demands. With an interconnected system, there is also the possibility of bringing other, currently independent sources (such as

DWU reuse water) and new water supply sources (Toledo Bend, Oklahoma, etc.) into the interconnected system to enhance the potential for water sharing.

To satisfy the DWU demands as they are represented in the model, the full yield of Lake Palestine (102 mgd) is needed immediately if the two systems remain separate. If conveyance systems are interconnected, use of Lake Palestine could ramp up gradually (assuming TRWD water supply in excess of projected demands could help satisfy DWU demand). This offers significant benefits with respect to phased infrastructure that are not available with separate systems.

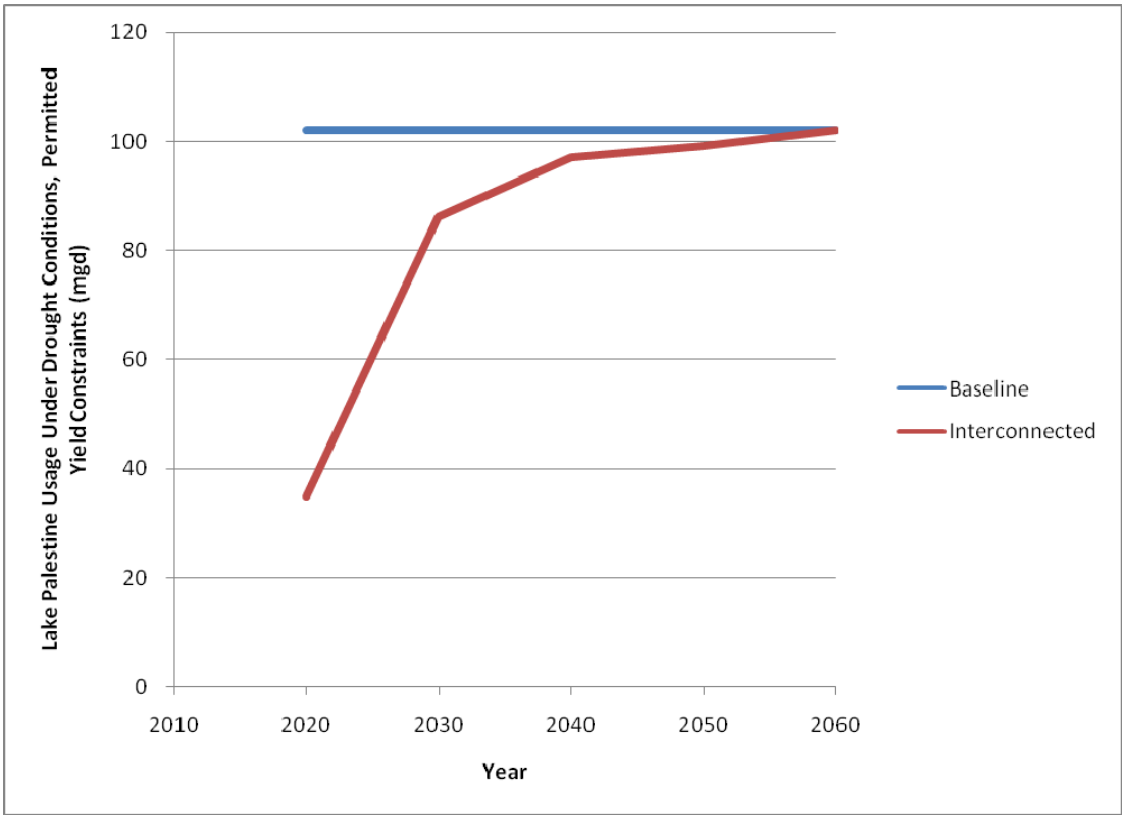


Figure 2-4
Potential Impact on Lake Palestine Timing (Assuming DWU Demand Constant at 102 mgd, Drought Conditions, Permitted Yield Constraints)

2.4.3 Redundancy

Operational redundancy is a "belt and suspenders" approach to risk management that enables the water supplier to select from multiple supply sources in times of emergency, drought, failure, etc. An interconnected supply system therefore provides more opportunity for supply and failure risk management.

In the event of a pipe failure or power outage, an integrated transmission system has more alternative flow pathways and connections to multiple water and power sources. These additional connections lower risk to the water provider. The impacts

of climatic variations are also lessened because of the diversification of reservoir locations. An interconnected system "casts a wider net" to reservoirs in different watersheds that will potentially experience drought in different times or levels of severity. Also, access to additional sources that may not be fully utilized adds supply redundancy to the system.

2.4.4 Operational Flexibility

Under prevailing ("normal") hydrologic conditions when the modeled system is not supply-limited, an interconnected system offers more operational flexibility than separate sources, since multiple flow pathways could be used to transport water. Such flexibility could be used to capitalize on advantageous opportunities for blending of sources, pump cycling schedules, system maintenance and energy management. One potential disadvantage of operations in an integrated system is the potential for increased operational complexity and the attendant new systems and protocols that must be developed to manage such a system.

The interconnected system also provides flexibility in terms of water availability. Extra supply is available through 2060 in an interconnected system and the analysis indicates that the TRWD system can support sustained withdrawals above the current permitted levels. This ability to overdraft supply sources provides flexibility to system operations, the potential for lower operating costs, and risk mitigation.

The National Water Research Institute in its November 2007 white paper entitled "Water 2010: A 'Near Sighted' Program of Water Resource Management Improvements for the Western United States" recommended system interties as its number one action item for state and local policymakers. NWRI concluded that "System interties increase the flexibility of system operators to respond to weather events, natural disasters, contaminations incidents, or the need to take water treatment or conveyance facilities temporarily off-line for repair or refurbishment……many interconnections can be planned and constructed within just a few years and at a relatively low cost."

2.4.5 Regional Cooperation

TRWD and DWU have a long history of cooperation in water supply planning, including the Texas Water Development Board regional water planning efforts initiated by the 1997 passage of Senate Bill 1 in the 75th session of the Texas Legislature. This on-going cooperation has led to this study and the potential for raw water transmission system interconnection. The interconnection of the two systems provides opportunities for benefit to both agencies by laying the groundwork for interconnecting future water supply sources (Toledo Bend, Oklahoma, etc.), increasing the portfolio of water supply options, reducing the costs of right-of-way through earlier acquisition, providing financing risk management, and compliance with TWDB planning guidelines.

The groundwork for regional cooperation in accessing future water supply options has already been laid; integrated water supply infrastructure provides additional opportunity for cost savings and will facilitate future inter-local agreements. By interconnecting the transmission system, each agency also effectively increases its portfolio of water supply options through the potential to share water and infrastructure.

Escalating costs for right-of-way acquisition (and urbanization) also point to the benefits of securing transmission routes early. This early acquisition presents an opportunity to acquire sufficient right-of-way for future joint water supplies. TRWD has recently experienced the following average costs for securing easements for several large diameter transmission system projects, costs which raise the issue of expedited acquisition of right-of-way for this and other future joint projects:

- Real estate classified as rural - $15,415 per acre.
- Real estate classified as undeveloped, planned - $33,792 per acre.
- Real estate classified as developed - $71,247 per acre.

Escalation in the cost of materials and ever increasing pressure on the financing market also point to the benefits of interconnection. Economies of scale and the ability to leverage the joint financing capacity of both agencies are benefits in integration.

Along with the other opportunities for benefits through integration, this regional cooperation is in compliance with TWDB guidelines for water supply planning. These guidelines and the TWDB planning process require this cooperation.

2.5 Summary Conclusion

From an operational perspective, the analysis supports further investigation of interconnected conveyance alternatives. Unlike separate systems, an interconnected system that routes Lake Palestine through the planned TRWD system offers reduced operating costs, cost sharing, savings due to infrastructure phasing, opportunities for water sharing, the potential for increased overall system yield and supply reliability, redundancy, and operational flexibility with respect to infrastructure scheduling and daily operations.

These results indicate a broad range of potential benefits that could be realized with an interconnected system as opposed to separate systems. Subsequent sections of this report address other factors relevant to interconnections, such as water quality, treatment requirements, environmental impacts, etc. Subsequent phases of work will establish operating protocols and cost agreements for shared conveyance and shared supply, and will address permitting needs.

Section 3
Lifecycle Cost Analysis

3.1 Purpose

The purpose of this cost analysis task was to develop a screening level/conceptual opinion of probable capital and lifecycle cost for each project conveyance alternative and to conduct a present worth economic comparison between the Baseline and Interconnection alternatives. The cost analyses represent total costs for water delivery and do not allocate costs between DWU and TRWD. The capital cost opinions presented herein are based on guidelines established by the Texas Water Development Board (TWDB) for use in regional water planning activities. The primary deviation from the TWDB guidelines is that the lifecycle cost analyses presented below consider escalation in power, operations and maintenance, and replacement costs while the TWDB guidelines specify development of a current (i.e., non-escalated) estimated annual cost for use in comparisons of alternative water management strategies.

The four project conveyance alternatives (described in **Table 1-1** and reproduced below for the reader's convenience) were compared in this cost analysis. The reader should refer to **Figures 1-4** through **1-8** for maps of pipeline routes used in each conveyance alternative.

Alternative	Description
1 (Baseline)	Independent Systems: TRWD's East Texas Third Pipeline and DWU's connection of Lake Palestine to the proposed Southeast Water Treatment Plant
2 (Baseline)	Independent Systems: TRWD's East Texas Third Pipeline and DWU's connection of Lake Palestine to Joe Pool Lake
3 (Interconnection)	Integrated System: Interconnected Third Pipeline (upsized as compared to the baseline condition) with connection of Lake Palestine to Cedar Creek Reservoir and delivery to DWU at Joe Pool Lake and TRWD's customers through the Third Pipeline
4 (Interconnection)	Integrated System: Interconnected "Southern Pipeline" - Lake Palestine delivered to the Lake Benbrook pipeline via a pipeline route to the south of the TRWD Third Pipeline route. Delivery to DWU at Joe Pool Lake and TRWD's customers through connections to the existing system and the Lake Benbrook pipeline.

Screening level/conceptual capital cost analyses for each project conveyance alternative are presented below. Background information and the results of the life-cycle cost analysis are then presented along with a discussion of the life-cycle cost analysis method. The reader should refer to section 1.4.2 for a discussion of the uncertainties and limitations associated with the development of this preliminary cost analysis and section 1.4.3 for recommendations for future cost analyses that will help refine the cost information and provide differentiation between Interconnection alternatives.

3.2 Capital Cost Analysis

The conceptual capital cost estimates for each project conveyance alternative are presented in **Table 3-1**. The table also contains the component pieces of the baseline alternatives broken down into individual capital cost estimates. The pipelines that compose these conveyance alternatives are:

TRWD Baseline Third Pipeline

- Cedar Creek to Ennis Pump Station
- Richland-Chambers to Ennis Pump Station
- Ennis Pump Station to Rolling Hills Water Treatment Plant

DWU Baseline

- Lake Palestine to Southeast WTP; or
- Lake Palestine to Joe Pool Lake

Interconnected Third Pipeline

- Lake Palestine to Cedar Creek Reservoir
- Cedar Creek Reservoir to Ennis Pump Station
- Richland-Chambers to Ennis Pump Station
- Ennis Pump Station to Rolling Hills Water Treatment Plant

Interconnected Southern Pipeline

- Lake Palestine to Lake Benbrook (Southern Route)
- Cedar Creek to Southern Pipeline
- Richland-Chambers Reservoir to Southern Pipeline
- Southern Pipeline to Joe Pool Lake Interconnect (interconnect w/TRWD Lines but effectively adjacent to Joe Pool connection)

Table 3-1
Results of Conceptual Capital Cost Analysis

Baseline Alternatives	Capital Cost (2008 basis)
Alternative 1: TRWD Third Pipeline + DWU Lake Palestine to SE WTP	$1,177,844,000
(Component 1: DWU Lake Palestine to SE WTP)	(548,949,000)
(Component 2: TRWD Third Pipeline)	(628,894,000)
Alternative 2: TRWD Third Pipeline + Lake Palestine to Joe Pool Lake	$1,303,360,000
(Component 1: DWU Lake Palestine to Joe Pool Lake)	(674,466,000)
(Component 2: TRWD Third Pipeline)	(628,894,000)
Interconnection Alternatives	
Alternative 3: Interconnected Third Pipeline	$1,083,966,000
Alternative 4: Interconnected Southern Pipeline	$1,355,279,000

3.3 Lifecycle Cost Analysis

Results from the screening level life-cycle cost analyses are shown in **Table 3-2** and **Table 3-3**. **Table 3-2** presents results on a total cost basis over 50 years, a Present Value basis (2008 dollars), and on a unit cost basis (i.e. cost per 1,000 gallons). The comparison of life-cycle costs for each project conveyance alternative is presented in **Table 3-3**.

Each of the primary variables in these lifecycle calculations are described in the sections below **Table 3-4**. These variables were: debt service and the discount rate, renewal and replacement costs, operational (energy) costs, and operations and maintenance.

Unit costs are specifically excluded from these results because only a portion of the DWU and TRWD transmission systems were modeled and because costs and water volumes were not allocated between the two entities in this study (this analysis will be necessary in subsequent phases).

Table 3-2
Lifecycle Cost Analysis Results

Baseline Alternatives	Total Cost (50-year Life)	Present Value Cost
Alternative 1: TRWD Third Pipeline + DWU Lake Palestine to SE WTP	$6,043,044,000	$2,462,651,000
(Component 1: DWU Lake Palestine to SE WTP)	(2,738,178,000)	(1,198,104,000)
(Component 2: TRWD Third Pipeline)	(3,304,866,000)	(1,264,547,000)
Alternative 2: TRWD Third Pipeline + Lake Palestine to Joe Pool Lake	6,774,762,000	$2,776,834,000
(Component 1: DWU Lake Palestine to Joe Pool Lake)	(3,469,896,000)	(1,512,287,000)
(Component 2: TRWD Third Pipeline)	(3,304,866,000)	(1,264,547,000)
Interconnection Alternatives		
Alternative 3: Interconnected Third Pipeline	5,578,924,000	2,238,879,000
Alternative 4: Interconnected Southern Pipeline	6,306,874,000	2,740,189,000

*Note that interconnected alternatives include delivery to Joe Pool Lake, not the SEWTP.

Table 3-3
Lifecycle Cost Differences – Comparison of Project Conveyance Alternatives

Interconnection Alternative	Comparison Baseline Alternative	Total Cost Difference	Present Value Cost Difference
3 (Interconnected Third Pipeline)	1 (w/ Pal. to SE WTP)	$464,120,000	$223,771,000
3 (Interconnected Third Pipeline)	2 (w/ Pal. to Joe Pool)	1,195,837,000	537,954,000
4 (Interconnected Southern Pipeline)	1 (w/ Pal. to SE WTP)	$-263,830,000	$-277,538,000
4 (Interconnected Southern Pipeline)	2 (w/ Pal. to Joe Pool)	467,887,000	36,644,000

*Note that interconnected alternatives include delivery to Joe Pool Lake, not the SEWTP.

3.3.1 Discount Rate

The discount rate is calculated as the cost of debt for the organization that will build the project and is then adjusted as needed to account for elements of risk unique to each project scenario. Because all variables in this life-cycle cost analysis are costs (as opposed to investments), a higher discount rate is favorable; additional risk factors decrease the discount rate as opposed to the traditional increase that would typically occur in an "investment scenario". For the DWU Baseline alternatives, the cost of debt was assumed to be 4.88%, which is equal to the simple average of the interest rates for the series of bonds in the 2006 Waterworks and Sewer System Revenue Refunding and Improvement Bonds from the City of Dallas 2006 Annual Report. For the TRWD Baseline alternative, the cost of debt was assumed to be 5.07%, which is equal to the TRWD 2006 Series Water Revenue Bonds' average annual interest rate. For the Interconnected alternatives, 4.97% was used, which is the simple average of the cost of debt for DWU and TRWD.

With the discount rate set equal to the cost of debt quoted above, risk factors were then identified and quantified in terms of a percentage reduction in the discount rate. The following risk factors were quantified based on the team's expert opinion:

- Political Risk: As a consequence of DWU and TRWD having to coordinate efforts in an interconnected alternative, both of these alternatives were deemed to have some political risk resulting from a potential delay in construction of one year. The cost of this political risk was quantified as 0.20 percent.

- Construction Delay: A reduction in the Interconnected Southern Pipeline alternative discount rate was applied to account for the potential delays associated with real estate acquisition (e.g., easements for pipelines). It was assumed that pipeline construction could begin prior to and concurrent with acquisition of all required easements. This risk was quantified as 0.40 percent to reflect a potential two-year delay in construction. Similarly, a reduction in the DWU Baseline alternatives' discount rate was quantified as 0.30 percent to represent an 18 month delay associated with procuring right-of-way easements. This delay is assumed to be less than the delay for the Interconnected Southern Pipeline alternative because of the relatively shorter pipeline length required for the DWU Baseline alternatives.

The discount rates applied in the 50-year life cycle cost analysis for each component of the project conveyance alternatives are summarized below in **Table 3-4**.

Table 3-4
Discount Rates

Components of Baseline Alternatives	Discount Rate	Interconnection Alternatives	Discount Rate
Lake Palestine to Joe Pool Lake		Interconnected 3rd Pipeline	
Cost of Debt	4.88%	Cost of Debt	4.97%
Cost of Delay	-0.30%	Political Risk	-0.20%
Total	4.58%	Total	4.77%
Lake Palestine to SE WTP			
Cost of Debt	4.88%	Southern Pipeline	
Cost of Delay	-0.30%	Cost of Debt	4.97%
Total	4.58%	Political Risk	-0.20%
TRWD Third Pipeline		Cost of Delay	-0.40%
Cost of Debt	5.07%	Total	4.37%
Total	5.07%		

3.3.2 Renewal and Replacement Costs

Some infrastructure elements will require replacement during the 50-year life-cycle of the system. The renewal and replacement analysis captured this element of cost for each project scenario. An example of renewal and replacement cost assumptions applied to the Interconnected Third Pipeline is shown in the **Table 3-5**.

Table 3-5
Renewal and Replacement: Average Years to Renewal

	Channel Dam / Intake	Pump Stations (Elec/Mech Equipment)	Tanks	Pipelines	Disinfection /Surge Control
Average Years to Renewal	50	30	50	50	25

It was assumed that only the pump stations and disinfection/surge control equipment are likely to require replacement during the 50-year project life-cycle. Estimated equipment life was obtained from the TCEQ System of Accounts, June 1999. It was assumed that 40 percent of the original capital costs will be required to replace certain elements of the pump station facilities and that the remaining 60 percent represents structural components, which have a significantly longer life expectancy. The pump station replacement cost was increased by another 20 percent to act as a contingency for unquantified pump station renewal costs.

For this analysis, the disinfection/surge control equipment was assumed to require 100 percent replacement and an additional 20 percent was added for contingency. The renewal and replacement costs for both pump stations and disinfection/surge control equipment were then inflated by the projected long-term U.S. inflation rate to estimate the capital costs at the time of renewal or replacement.

3.3.3 Energy Costs

Energy costs were calculated as the product of an assumed energy rate and the usage for each project conveyance alternative. The energy usage was based on the system operations model (see Section 2), which calculated operational costs (energy) in kilowatt hours (kWh) over seven years of assumed hydrologic conditions, either drought or normal. For the life-cycle cost analysis, energy usage during normal hydrologic conditions was used to represent average conditions over the 50-year life-cycle.

The energy rate was based on data from the Electric Reliability Council of Texas (ERCOT) for electric power delivered within the ERCOT North Texas Zone; an energy rate of $0.084/kwh was used in this analysis .This rate was not escalated over the course of the 50-year lifecycle of each project based on the US Department of Energy Annual Energy Outlook 2008 Energy Prices by Sector and Source forecast.

3.3.4 Operations and Maintenance Costs

Operations and maintenance (O&M) costs for each project alternative were calculated in accordance with Texas Water Development Board (TWDB) guidelines for regional water supply planning. TWDB guidelines provide an estimated fixed percentage of construction cost for various types of facilities to estimate O&M costs. The construction cost is the capital cost for each facility type and does not include financing or other related costs.

O&M costs were escalated over time using the inflation rate, projected as the long-term U.S. inflation rate according to the U.S. Bureau of Labor Statistics. Its intent was to capture the increase in wages and other costs associated with operations and maintenance. Energy costs were not included in this O&M cost calculation because they were considered independently. An example of the estimated annual O&M costs for the Interconnected Third Pipeline alternative is shown in **Table 3-6**.

Table 3-6
Operations and Maintenance as a Percentage of Construction Cost

	Channel Dam / Intake	Pump Stations	Tanks	Pipelines	Disinfection / Surge Control
O&M as % of Construction Cost	1.50%	2.50%	2.50%	1.00%	2.50%

3.4 Lifecycle Cost Analysis Conclusions

The purpose of the cost analysis task was to develop a screening level/conceptual opinion of probable capital and lifecycle cost for each project conveyance alternative and to conduct a present worth economic comparison between the Baseline and Interconnection alternatives. Results were presented above in **Tables 3-2** and **3-3** and show that there are opportunities for significant cost savings through an integration of the raw water transmission systems to deliver Lake Palestine water to DWU and TRWD.

Delivering water through an Interconnected Third Pipeline has potential Present Value, 50-year life-cycle cost savings between approximately $220,000,000 and $540,000,000.

The Interconnected Southern Pipeline alternative has potential Present Value, 50-year life-cycle cost savings when compared to Alternative 2 (baseline with delivery to Joe Pool) but increased cost when compared to Alternative 1 (baseline with delivery to SE WTP). However, because the Interconnected Southern Pipeline delivers water to Joe Pool Lake and not the SE WTP, the most direct comparison is between the Interconnected Southern Pipeline and Alternative 2, which results in an approximate $36,600,000 savings. Subsequent phases of this feasibility assessment will consider other potential benefits from the Southern Pipeline, such as supply risk reduction and right-of-way acquisition for future supplies. For example, TRWD has recently experienced the following average costs for securing easements for several large diameter transmission system projects:

- Real estate classified as rural - $15,415 per acre.
- Real estate classified as undeveloped, planned - $33,792 per acre.
- Real estate classified as developed - $71,247 per acre.

These costs raise the issue of expedited acquisition of right-of-way (e.g. in the Southern Pipeline route) to manage the availability and cost of acquisition for this and future water supplies. Also, phasing could also result in significant reduction of costs associated with the Interconnected Southern Pipeline due to the potential to defer development of transmission facilities required to deliver water to Lake Benbrook.

Section 4
Constraints Analysis

A preliminary facility siting constraints analysis was performed to identify potential fatal flaws to locating water transmission facilities along select pipeline corridors and to make a comparison between project conveyance alternatives. The data collected for the constraints analysis will also have use during subsequent phases of engineering. The preliminary constraints analysis was accomplished using publicly available data from secondary sources (no field data collection). A database of constraint data and aerial photography was developed using Geographic Information System (GIS) applications software. Using this spatial data, a team of subject matter experts identified potential facility siting constraints in three categories: land use, environmental, and technical (engineering). After relevant data was compiled and analyzed for each potential constraint, subject matter experts rated the potential for impact as "High", "Medium", "Low", or "No Impact" and the team then came to a consensus on the overall potential impact on each transmission corridor.

The facility siting constraints analysis is summarized in the Alternatives Evaluation Matrix (AEM). This tool is simply a tabulation of the constraints within the three impact categories, beginning with the generalized "Impact Category", which is then broken down into "Evaluation Criteria", which are comprised of "Components". Basic facility data is also included in the AEM to identify each alternative and quantify dimensions and capacities of water transmission infrastructure.

This section summarizes the constraints analysis. First is a description of the infrastructure components in each of the four scenarios. Next is a discussion of the Alternatives Evaluation Matrix (AEM). Lastly, preliminary findings and consensus evaluations are presented.

4.1 Description of Alternatives

Like all other project analyses, the constraints analysis compared four project conveyance alternatives, which are listed in **Table 1-1** and reproduced here for the reader's convenience.

Alternative	Description
1 (Baseline)	Independent Systems: TRWD's East Texas Third Pipeline and DWU's connection of Lake Palestine to the proposed Southeast Water Treatment Plant
2 (Baseline)	Independent Systems: TRWD's East Texas Third Pipeline and DWU's connection of Lake Palestine to Joe Pool Lake
3 (Interconnection)	Integrated System: Interconnected Third Pipeline (upsized as compared to the baseline condition) with connection of Lake Palestine to Cedar Creek Reservoir and delivery to DWU at Joe Pool Lake and TRWD's customers through the Third Pipeline
4 (Interconnection)	Integrated System: Interconnected "Southern Pipeline" - Lake Palestine delivered to the Lake Benbrook pipeline via a pipeline route to the south of the TRWD Third Pipeline route. Delivery to DWU at Joe Pool Lake and TRWD's customers through connections to the existing system and the Lake Benbrook pipeline.

A brief description of the facilities used in each alternative, and the basis for their selection, follows. The reader should refer to **Figures 1-4 through 1-8** for mapping of the infrastructure components that make up each of the four project conveyance alternatives.

DWU Baseline – Palestine to Southeast WTP

DWU's primary baseline alternative for connecting Lake Palestine to the DWU service area is to construct a pipeline directly from Lake Palestine to the site of the proposed Southeast Water Treatment Plant (WTP) in Hutchins, TX. This baseline alternative consists of three principal components:

- An intake pump station at Lake Palestine;
- A single 84 inch pipeline from Lake Palestine to the Southeast WTP; and
- A booster pump station at Murchison, TX.

Almost two decades have passed since planning level studies were completed for this project alternative, which at the time included site selection for the Southeast WTP and the intake at Lake Palestine, and an alignment study for the transmission pipeline (see Lake Palestine Utilization and Pipeline Alignment Study, by Dannenbaum Engineering Corporation, June 1989). The recommended pipeline alignment and locations for the intake and WTP were used in this constraints analysis.

According to DWU staff, the Southeast WTP location recommended in the previous study is favorable for interconnection with the DWU distribution system. However, the WTP site is adjacent to two intermodal transportation facilities that will make development of a facility at that site difficult. The location of the WTP could be moved longitudinally along the previously studied pipeline alignment but suitable alternative sites are not readily available.

DWU Baseline – Lake Palestine to Joe Pool Lake

An alternative stand-alone baseline project for DWU is to construct a pipeline from Lake Palestine to Joe Pool Lake. This baseline alternative consists of three principal components:

- An intake pump station at Lake Palestine;
- A single 84 inch pipeline from Lake Palestine to Joe Pool Lake; and
- Two booster pump stations.

This baseline alternative was proposed for evaluation by DWU due to potential limitations to the original proposed site for the Southeast WTP. Delivery of Lake Palestine water to Joe Pool Lake offers potential advantages in terms of development of a new WTP in proximity to portions of the DWU service area where additional supplies are needed. A WTP site near Mountain Creek Lake would provide treatment capacity in close proximity to the high, medium, and low pressure planes of the DWU service area. Alternatively, Lake Palestine water supplies could be transferred from Joe Pool Lake to the existing DWU Bachman WTP (see Section 8 of this report), thereby freeing up raw water supplies from Lake Lewisville and Lake Ray Roberts for expansion of the DWU Elm Fork WTP.

Because the corridor between the Southeast WTP site and Joe Pool Lake is largely urbanized, the pipeline alignment for this baseline alternative would not follow the same route proposed for delivery to the Southeast WTP. Instead, it would follow a more southerly route from Lake Palestine to Joe Pool Lake, passing between the Richland-Chambers and Cedar Creek Reservoirs.

TRWD Baseline – Third Pipeline

TRWD's baseline alternative is to construct additional conveyance capacity to deliver water from Richland-Chambers Reservoir and Cedar Creek Lake to as far west as Rolling Hills WTP and intermediate delivery points. This "East Texas Third Pipeline" would share existing right-of-way with two existing TRWD pipelines. TRWD's baseline alternative consists of six principal components:

- Additional intake capacity at Richland-Chambers Reservoir and a 60 inch pipeline to the existing TRWD Ennis Booster Pump Station;
- Additional intake capacity at Cedar Creek Lake and a 72 inch pipeline to the Ennis Booster Pump Station;
- A single 84 inch pipeline to carry the combined additional flow from the Ennis Booster Pump Station to existing TRWD balancing reservoirs at Kennedale;
- A bi-directional 96 inch pipeline from the Kennedale balancing reservoirs to the Rolling Hills WTP;

- Additional pumping capacity at the existing TRWD pump stations at Ennis and Waxahachie; and

Because of the potential to share existing pipeline right-of-way and booster pump station infrastructure, the Third Pipeline is thought to be the lowest cost baseline alternative for TRWD to deliver additional raw water from its East Texas reservoirs

Interconnected Third Pipeline

This alternative would deliver raw water supplies from Lake Palestine through an interconnected system to both TRWD and DWU. This alternative includes the same principal components as the above TRWD baseline alternative, up-sized for the additional flow from Lake Palestine, and the following additional components:

- An intake pump station at Lake Palestine;
- A single 72 inch pipeline from Lake Palestine to Cedar Creek Reservoir; and
- A turnout from the Third Pipeline to deliver water to Joe Pool Lake.

Interconnected Southern Pipeline

This project conveyance alternative was considered as an option to the Interconnected Third Pipeline because of the potential benefits to system reliability (three pipelines in one shared transmission corridor may increase the risk of failure for all three lines and therefore lower the reliability of the East Texas supply), right-of-way acquisition, and phasing. This alternative would provide an alignment and reserve right-of-way for the transmission of future water supplies from East Texas and consists of the following principal components:

- An intake pump station at Lake Palestine;
- A single 108 inch pipeline from Lake Palestine to Benbrook Lake;
- A bi-directional 66 inch interconnection pipeline from Richland-Chambers Reservoir;
- A bi-directional 72 inch interconnection pipeline from Cedar Creek Lake;
- A 108 inch interconnection pipeline to Joe Pool Lake;
- Three booster pump stations.

The Interconnected Southern Pipeline would pass between Richland-Chambers and Cedar Creek Reservoirs. Interconnections with both reservoirs would provide flexibility to deliver Lake Palestine water into these reservoirs for temporary storage or to add supply from these lakes to the joint transmission line. These interconnects would increase operational flexibility and yield reliability.

Pipeline Corridors

At this stage of the Lake Palestine Project Viability Assessment, pipeline alignments were defined broadly, in spatial terms. The constraints analysis was performed on a two-mile wide corridor for each pipeline segment around an assumed centerline. Constraints data was analyzed to indicate the potential for utility, environmental, and other conflicts within each corridor rather than along the assumed centerline. The assumed centerline was defined by the project team by first assuming the shortest route between the beginning and end points, and then deviating from that line in consideration of apparent conflicts (e.g., towns, major water courses, road crossings, etc.). **Figure 4-1** shows an approximate centerline longitudinal surface elevation profile for some of the primary alternative routes.

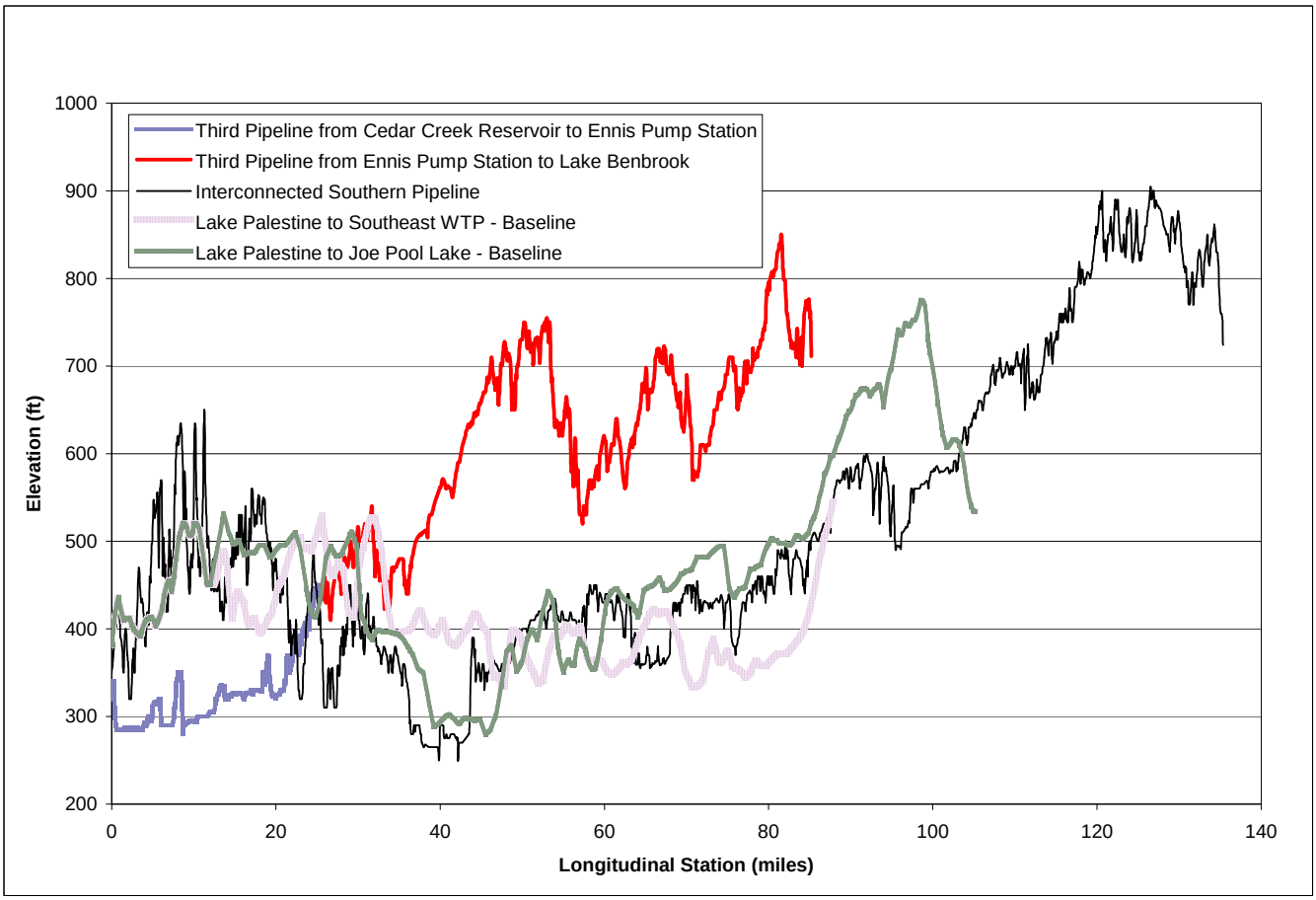


Figure 4-1
Approximate Pipeline Longitudinal Surface Elevation Profiles

4.2 Alternatives Evaluation Matrix

An Alternatives Evaluation Matrix (AEM) was developed to evaluate the occurrence and level of constraints for each pipeline in the project scenarios. This tool is simply a tabulation of the constraints within three classifications, beginning with the generalized "Impact Category", which is then subdivided into "Evaluation Criteria", which are further subdivided into "Components".

1. Impact Categories – Basic Data (not constraints, but necessary to the evaluation), Land Use, Environmental, and Technical (Engineering)

2. Evaluation Criteria – This subset of the impact categories represents the place at which ratings were assigned to the potential impact of constraints on a project alternative. For example, in the environmental impact category, the wetlands criteria may be rated as a High, Medium, Low, or None based on the data analyzed for each component.

3. Components – Each criterion is composed of several components, or attributes data, that become the basis for rating the potential impact. To continue with the previous example, the wetlands criteria components include forested wetlands, non-forested, waters of the U.S., etc.

The impact categories and evaluation criteria selected for the AEM are listed in **Table 4-1**.

To support the constraints analysis process, data were collected from reliable sources and stored in an ArcGIS 9 environment using a common spatial projection. A series of constraint maps were then designed so that the team could visualize potential constraints and their interrelationship. A list of the data and sources used for this analysis is shown in **Table 4-2**.

The final products of the constraints analysis were: 1) a collection of data needed for future phases of engineering, such as conceptual and preliminary design; and 2) a qualitative rating of the potential impact on each evaluation criteria and a consensus evaluation of the overall potential impact of the identified constraints on each project conveyance alternative. Subject matter experts provided an opinion based on the constraints data and rated the evaluation criteria. After each component was quantified and the evaluation criteria were rated, the evaluation team reached consensus on the overall potential impact rating for each scenario.

Table 4-1
Constraint Evaluation Criteria

Impact Category	Category ID No.	Evaluation Criteria
Basic Data	B.1	Intake Facilities; Intake pump station
	B.2	Transmission Facilities Pipelines and Booster PS
Land Use	L.1	Residences
	L.2	Commercial Businesses
	L.3	Schools
	L.4	Parks and Recreation Areas
	L.5	Oil & Gas
	L.6	Other Wells
	L.7	Hazardous Material Sites
	L.8	Airports
	L.9	Mines
	L.10	Existing Roads, Highways and Railroads
	L.11	Agriculture & Non-Tillable Land Based on Soil Type
	L.12	Land Use
Environmental	E.1	Vegetation
	E.2	Conservation
	E.3	Noise
	E.4	Wetlands/Water of the US
	E.5	Wildlife Habitats
	E.6	Cultural Resources
	E.7	Visual
Technical (Engineering)	T.1	Drainage and Hydrologic
	T.2	Electric Transmission Lines
	T.3	Topography
	T.4	Proximity to Infrastructure
	T.5	Site Conditions

Table 4-2
List of Source and Data Used in Constraint Analysis

Source	Base Map Data
National Hydrography Dataset/EPA	Streams
	Waterbodies
Texas Natural Resource Information System	Contours
	USGS Topographic Map Grid
Texas Railroad Commission	Abstracts
US Census Bureau	Cities
	Parks
	Streets
Source	**Constraint Data**
ERCOT	Electrical Transmission
Texas Commission on Environmental Quality	Impaired Streams
	Impaired Water Bodies
	Permitted Industrial Hazardous Waste Sites
	Radioactive Waste Sites
	Superfund Cleanup Sites
	Surface Water Rights
	Wastewater Outfalls
Texas Education Agency	School Districts
	Schools
Texas Historical Commission	Historical Markers
Texas Historical Commission and USGS	Cemeteries
Texas Parks and Wildlife	State Parks
	Threatened and Endangered Species
	Vegetation Type
Texas Railroad Commission	Oil and Gas Pipelines
	Oil and Gas Wells
Texas Water Development Board	Groundwater Wells
United States Department of Agriculture	Soils/Farm Lands
US Census Bureau	Airports
USGS	Land Use
USGS/National Atlas	Agricultural Mine
	Crushed Stone Mines
	Federal Lands
	National Parks
	Sand/Gravel Mines

4.3 Preliminary Findings and Consensus Evaluations

The preliminary findings of the constraints analysis are contained in the Alternatives Evaluation Matrix (AEM), with an analysis of each evaluation criterion and component, and an impact rating for each evaluation criterion. Using the ratings from each impact category and the opinions of the subject matter experts, a consensus evaluation was reached for each project conveyance alternative. The consensus evaluation is summarized in **Table 4-3**, **Table 4-4** and **Table 4-5.**

The evaluation team agreed that, based on the available data, no fatal flaws were detected in this analysis and each of the pipeline corridors are potentially viable and can be recommended for further analysis.

The consensus evaluations in **Table 4-3**, **Table 4-4** and **Table 4-5** also show that, based on the available data, there are no significant differentiators between project alternatives in terms of land use, environmental, or technical (engineering) constraints. Differentiation in terms of lifecycle cost, reliability, operations and maintenance, water quality, and other factors is addressed in other sections of this report. Subsequent phases of project definition and development will provide the quantitative data needed to differentiate the occurrence and significance of constraints within each alternative pipeline corridor

Table 4-3
Baseline Alternatives Constraints Analysis Consensus Evaluations

Impact Category	Category ID No.	Evaluation Criteria	Baseline				
			DWU 2	DWU 1	TRWD		
			Palestine to JP	Palestine to SE WTP	CC to Ennis	RC to Ennis	Ennis to RHWTP
Basic Data	B.1	Intake Facilities; Intake pump station	--	--	--	--	--
	B.2	Transmission Facilities Pipelines and Booster PS	--	--	--	--	--
Land Use	L.1	Residences	Low	Low	Low	Low	Low
	L.2	Commercial Businesses	Low	Low	Low	Low	Low
	L.3	Schools	None	None	None	None	None
	L.4	Parks and Recreation Areas	None	Low	None	None	Low
	L.5	Oil & Gas	Med	Low	Low	Med	High
	L.6	Other Wells	Low	Low	Low	Low	Low
	L.7	Hazardous Material Sites	Low	Low	Low	Low	Low
	L.8	Airports	Low	Low	Low	Low	Low
	L.9	Mines	Low	Low	Low	Low	Low
	L.10	Existing Roads, Highways and Railroads	Med	Med	Low	Med	High
	L.11	Agriculture & Non-Tillable Land Based on Soil Type	Low	Low	Low	Low	Low
	L.12	Land Use	Med	Med	Low	Low	Med
Environ-mental	E.1	Vegetation	Med	Med	Low	Low	Med
	E.2	Conservation	None	None	None	None	None
	E.3	Noise	Low	Low	Low	Low	Low
	E.4	Wetlands/Water of the US	Med	Med	Low	Med	Med
	E.5	Wildlife Habitats	Med	Med	Med	Med	Med
	E.6	Cultural Resources	Med	Med	Low	Low	Med
	E.7	Visual	Low	Low	Low	Low	Low
Technical (Engin-eering)	T.1	Drainage and Hydrologic	Med	Med	Low	Low	Low
	T.2	Electric Transmission Lines	Med	Low	Low	Low	High
	T.3	Topography	Low	Low	Low	Low	Low
	T.4	Proximity to Infrastructure	Low	Low	Low	Low	Low
	T.5	Site Conditions	Med	High	Med	low	Low
Consensus Evaluation of Constraint Level			Med	Med	Low	Low	Med

Table 4-4
Interconnected Third Pipeline Alternative Constraints Analysis Consensus Evaluations

Impact Category	Category ID No.	Evaluation Criteria	Interconnected Third Pipeline			
			Pal to CC	CC to Ennis PS	RC to Ennis	Ennis to RHWTP
Basic Data	B.1	Intake Facilities; Intake pump station	--	--	--	--
	B.2	Transmission Facilities Pipelines and Booster PS	--	--	--	--
Land Use	L.1	Residences	Low	Low	Low	Med
	L.2	Commercial Businesses	Low	Low	Low	Low
	L.3	Schools	None	None	None	None
	L.4	Parks and Recreation Areas	None	None	None	None
	L.5	Oil & Gas	Med	Low	Med	High
	L.6	Other Wells	Low	Low	Low	Low
	L.7	Hazardous Material Sites	Low	Low	Low	Low
	L.8	Airports	Low	Low	Low	Low
	L.9	Mines	Low	Low	Low	Low
	L.10	Existing Roads, Highways and Railroads	Med	Low	Med	High
	L.11	Agriculture & Non-Tillable Land Based on Soil Type	Low	Low	Low	Low
	L.12	Land Use	Low	Low	Low	Med
Environ-mental	E.1	Vegetation	Low	Low	Low	Med
	E.2	Conservation	Low	None	None	None
	E.3	Noise	Low	Low	Low	Low
	E.4	Wetlands/Water of the US	Med	Low	Med	Med
	E.5	Wildlife Habitats	Med	Med	Med	Med
	E.6	Cultural Resources	Low	Low	Low	Med
	E.7	Visual	Low	Low	Low	Low
Technical (Engin-eering)	T.1	Drainage and Hydrologic	Med	Low	Low	Low
	T.2	Electric Transmission Lines	Low	Low	Low	High
	T.3	Topography	Low	Low	Low	Low
	T.4	Proximity to Infrastructure	Low	Low	Low	Low
	T.5	Site Conditions	High	Med	Low	Low
Consensus Evaluation of Constraint Level			Med	Low	Low	Med

Table 4-5
Interconnected Southern Pipeline Alternative Constraints Analysis Consensus Evaluations

Impact Category	Category ID No.	Evaluation Criteria	Interconnected Southern Pipeline			
			Pal to Benbrook	CC to Southern Rte	RC to Southern Rte	So Rte to JP (intcnct)
Basic Data	B.1	Intake Facilities; Intake pump station	--	--	--	--
	B.2	Transmission Facilities Pipelines and Booster PS	--	--	--	--
Land Use	L.1	Residences	Low	Low	Low	Low
	L.2	Commercial Businesses	Low	Low	Low	Low
	L.3	Schools	None	None	None	None
	L.4	Parks and Recreation Areas	None	None	None	None
	L.5	Oil & Gas	High	Low	High	High
	L.6	Other Wells	Low	Low	Low	Low
	L.7	Hazardous Material Sites	Low	Low	Low	Low
	L.8	Airports	Low	Low	Low	Low
	L.9	Mines	Low	Low	Low	Low
	L.10	Existing Roads, Highways and Railroads	High	Med	High	Med
	L.11	Agriculture & Non-Tillable Land Based on Soil Type	Low	Low	Low	Low
	L.12	Land Use	Low	Low	Low	Low
Environ-mental	E.1	Vegetation	Med	Low	Low	Low
	E.2	Conservation	None	None	None	None
	E.3	Noise	Low	Low	Low	Low
	E.4	Wetlands/Water of the US	Med	Low	Low	Med
	E.5	Wildlife Habitats	Med	Med	Med	Low
	E.6	Cultural Resources	Low	Low	Low	Low
	E.7	Visual	Low	Low	Low	Low
Technical (Engin-eering)	T.1	Drainage and Hydrologic	Med	Low	Med	Med
	T.2	Electric Transmission Lines	Med	Med	Med	High
	T.3	Topography	Low	Low	Low	Low
	T.4	Proximity to Infrastructure	Low	Low	Low	Low
	T.5	Site Conditions	Med	Med	Low	Low
Consensus Evaluation of Constraint Level			Med	Low	Med	Med

Section 5
Environmental Water Quality

The purpose of the environmental water quality review was to assess receiving water quality impacts due to the introduction of Lake Palestine water under varying conditions into Lake Benbrook, Cedar Creek Reservoir, Richland-Chambers Reservoir, and Joe Pool Lake. The water quality review included data collection and analysis, mass balance calculations, and a water quality evaluation.

5.1 Data Collection and Analyses

Multiple sources, including the United States Army Corps of Engineers (USACE), TRWD, Trinity River Authority (TRA), Upper Neches River Municipal Water Authority, and the Texas Commission on Environmental Quality (TCEQ), were used to obtain daily historical reservoir storage and water quality data for this study. Reservoir volume data were analyzed for the following time periods in each of these reservoirs:

- Lake Benbrook: January 1980 - December 2007
- Cedar Creek Reservoir: January 1980 - December 2007
- Richland-Chambers Reservoir: January 1989 - December 2007
- Joe Pool Lake: January 1990 - September 2007.

Water quality data were collected and evaluated for each reservoir from January 1997 through December 2006 for alkalinity, dissolved iron, dissolved manganese, hardness, total dissolved solids, total organic carbon, pH, chlorophyll-A, dissolved oxygen, nitrite + nitrate, orthophosphate phosphorus, total phosphorus, secchi depth, and temperature.

Water quality data from TRWD's field-scale wetland system was collected and analyzed from June 2003 through March 2007. Because not all of the water quality parameters analyzed in the study reservoirs were available from TRWD's field-scale wetland system, this evaluation was limited to the following parameters: alkalinity, hardness, nitrite + nitrate, orthophosphate phosphorus, and total phosphorus.

For comparison purposes, the 2006 Region C Water Plan included an assessment of 5 key surface water quality parameters (ammonia nitrogen, nitrate nitrogen, total phosphorus, chlorophyll-a, and total dissolved solids) in its evaluation of water quality impacts for the recommended water management strategies based upon historical median concentrations of the parameters in the source and receiving waters.

5.2 Environmental Water Quality Mass Balance

As part of this water quality assessment, a water quality mass balance was performed to analyze the impact on water quality due to introducing Lake Palestine water into Lake Benbrook, Cedar Creek Reservoir, Richland-Chambers Reservoir, and/or Joe Pool Lake. The water quality parameters evaluated utilizing a mass balance approach include:

- Alkalinity
- Dissolved Iron
- Dissolved Manganese
- Hardness
- Total Dissolved Solids
- Total Organic Carbon
- Chlorophyll-A
- Dissolved Oxygen
- Nitrite + Nitrate
- Orthophosphate Phosphorus
- Total Phosphorus.

The mass balance calculation utilized the historical water quality conditions shown in **Table 5-1** with the introduction of 102 MGD of water from Lake Palestine over a 3 and 6 month period. Lake Palestine water was added to the receiving reservoir as a volume with a specified concentration. The volume of Lake Palestine water was calculated by multiplying 102 MGD by 90 days for the 3 month mass balance and by 180 days for the 6 month mass balance. Lake Palestine water was introduced under various reservoir volume conditions for Lake Benbrook, Cedar Creek Reservoir, Richland- Chambers Reservoir, and Joe Pool Lake. The destination reservoirs were evaluated at reservoir volume conditions equal to the 50th, 75th, and 90th percentile of historical volume and at 50%, 75%, and 90% of the conservation storage capacity. **Table 5-2**, through **Table 5-5** present the results of the calculated water quality concentrations of each parameter after the introduction of Lake Palestine water.

When available, water quality data from the main body of the reservoirs was utilized. Water quality data from TRWD's field-scale wetland system into Alligator Creek was also utilized for this analysis. Average water quality parameter concentrations were calculated for 3 and 6 month time periods from January 1997 through December 2006 for the reservoirs and from June 2003 through March 2007 for the wetland system. The 3 month averages include the months of July through September and the 6 month averages include the months of June through November. For each parameter in the reservoirs, the 3 and 6 month averages were developed by first averaging the concentrations of samples taken at different depths at the same location at the same time. Then, the concentrations for samples taken on the same date in the main pool of the reservoir were averaged to obtain an overall concentration for the reservoir on each sample date. Finally, the concentrations for dates that fell within the 3 and 6 month time period were averaged to acquire one concentration for each time period that would represent the overall average concentration in the main pool of the reservoir. The Alligator Creek data did not have multiple sampling locations, depths, or multiple samples per day; therefore, the wetland system data was simply averaged in 3 and 6 month time periods.

Table 5-1
Average Background Concentrations for Treatability and Nutrient Parameters

	Parameter	Time Period	Benbrook	Cedar Creek	Richland-Chambers	TRWD Wetland	Joe Pool	Palestine
Treatability Parameters	Alkalinity (mg/L)	3 Month	96.67	59.59	86.25	121.26	102.69	37.50
		6 Month	106.81	61.82	90.51	113.02	106.04	37.85
	Dissolved Iron (ug/L)	3 Month	22.78	26.14	33.91	---	67.74	110.00
		6 Month	22.58	78.73	40.53	---	59.02	110.00
	Dissolved Manganese (ug/L)	3 Month	28.17	132.43	35.64	---	103.77	250.00
		6 Month	24.73	82.61	30.62	---	90.48	250.00
	Hardness (mg/L)	3 Month	140.00	50.00	95.00	171.96	149.38	40.00
		6 Month	140.00	50.00	95.00	167.41	153.17	47.67
	Total Dissolved Solids (mg/L)	3 Month	181.47	130.46	153.48	---	318.88	138.60
		6 Month	189.17	131.71	159.36	---	312.55	138.41
	Total Organic Carbon (mg/L)	3 Month	5.18	6.94	5.39	---	4.05	8.63
		6 Month	5.25	6.91	5.41	---	4.76	8.50
	pH	3 Month	7.98	8.20	8.10	---	8.08	7.65
		6 Month	7.96	8.10	8.07	---	8.13	7.55
Nutrient Parameters	Chlorophyll-A (ug/L)	3 Month	31.57	34.07	21.10	---	6.85	42.83
		6 Month	26.63	30.21	20.98	---	6.85	39.39
	Dissolved Oxygen (mg/L)	3 Month	5.62	5.56	4.85	---	6.39	5.26
		6 Month	5.96	6.21	5.48	---	7.22	5.51
	Nitrite + Nitrate (mg/L)	3 Month	0.01	0.03	0.03	0.11	0.06	0.38
		6 Month	0.02	0.07	0.06	0.20	0.08	0.42
	Orthophosphate Phosphorus (mg/L)	3 Month	0.01	0.04	0.02	0.82	0.02	0.06
		6 Month	0.01	0.03	0.01	0.60	0.02	0.06
	Total Phosphorus (mg/L)	3 Month	0.08	0.11	0.08	0.81	0.03	0.08
		6 Month	0.07	0.10	0.08	0.61	0.06	0.10
	Secchi Depth (m)	3 Month	0.73	0.76	0.93	---	1.07	0.82
		6 Month	0.81	0.78	0.88	---	1.03	0.77
	Temperature (^{o}C)	3 Month	26.73	28.63	27.80	---	28.73	28.20
		6 Month	25.35	26.72	26.11	---	26.29	26.04

Table 5-2
Water Quality Concentrations in Lake Benbrook with the Inclusion of 102 MGD of Lake Palestine Water

					Benbrook Historical Volume by Percentile (acre-feet)			Benbrook Volume by Percentage of Conservation Storage (acre-feet)		
					50th	75th	90th	50%	75%	90%
					81,960	86,240	89,402	42,824	64,236	77,083
		Background Concentrations			Benbrook Parameter Concentrations after Blending 102 MGD of Lake Palestine Water					
	Parameter	Time Period	Benbrook	Palestine						
Treatability Parameters	Alkalinity (mg/L)	3 Month	96.67	37.50	81.29	81.86	82.26	72.88	78.36	80.58
		6 Month	106.81	37.85	78.44	79.29	79.88	67.35	74.30	77.41
	Dissolved Iron (ug/L)	3 Month	22.78	110.00	45.46	44.61	44.03	57.85	49.78	46.50
		6 Month	22.58	110.00	58.55	57.47	56.72	72.61	63.79	59.85
	Dissolved Manganese (ug/L)	3 Month	28.17	250.00	85.85	83.70	82.21	117.36	96.83	88.50
		6 Month	24.73	250.00	117.40	114.64	112.70	153.63	130.92	120.77
	Hardness (mg/L)	3 Month	140.00	40.00	114.00	114.97	115.64	99.79	109.05	112.80
		6 Month	140.00	47.67	102.01	103.15	103.94	87.16	96.47	100.64
	Total Dissolved Solids (mg/L)	3 Month	181.47	138.60	170.33	170.74	171.03	164.24	168.20	169.81
		6 Month	189.17	138.41	168.29	168.91	169.35	160.13	165.24	167.53
	Total Organic Carbon (mg/L)	3 Month	5.18	8.63	6.08	6.04	6.02	6.57	6.25	6.12
		6 Month	5.25	8.50	6.59	6.55	6.52	7.11	6.78	6.64
	pH	3 Month	7.98	7.65						
		6 Month	7.96	7.55						
Nutrient Parameters	Chlorophyll-A (ug/L)	3 Month	31.57	42.83	34.50	34.39	34.31	36.10	35.05	34.63
		6 Month	26.63	39.39	31.88	31.72	31.61	33.93	32.64	32.07
	Dissolved Oxygen (mg/L)	3 Month	5.62	5.26	5.53	5.53	5.54	5.48	5.51	5.53
		6 Month	5.96	5.51	5.78	5.78	5.78	5.70	5.75	5.77
	Nitrite + Nitrate (mg/L)	3 Month	0.01	0.38	0.11	0.11	0.10	0.16	0.13	0.11
		6 Month	0.02	0.42	0.19	0.18	0.18	0.25	0.21	0.19
	Orthophosphate Phosphorus (mg/L)	3 Month	0.01	0.06	0.02	0.02	0.02	0.03	0.02	0.02
		6 Month	0.01	0.06	0.03	0.03	0.03	0.04	0.03	0.03
	Total Phosphorus (mg/L)	3 Month	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
		6 Month	0.07	0.10	0.08	0.08	0.08	0.09	0.09	0.09
	Secchi Depth (m)	3 Month	0.73	0.82						
		6 Month	0.81	0.77						
	Temperature (°C)	3 Month	26.73	28.20						
		6 Month	25.35	26.04						

Table 5-3
Water Quality Concentrations in Cedar Creek Reservoir with the Inclusion of 102 MGD of Lake Palestine Water

					Cedar Creek Historical Volume by Percentile (acre-feet)			Cedar Creek Volume by Percentage of Conservation Storage (acre-feet)		
					50th	75th	90th	50%	75%	90%
					619,743	636,241	639,596	322,393	483,589	580,307
	Parameter	Background Concentrations			Cedar Creek Parameter Concentrations after Blending 102 MGD of Lake Palestine Water					
		Time Period	Cedar Creek	Palestine						
Treatability Parameters	Alkalinity (mg/L)	3 Month	59.59	37.50	58.60	58.63	58.63	57.77	58.34	58.54
		6 Month	61.82	37.85	59.80	59.84	59.85	58.21	59.29	59.67
	Dissolved Iron (ug/L)	3 Month	26.14	110.00	29.87	29.77	29.76	33.02	30.86	30.11
		6 Month	78.73	110.00	81.37	81.31	81.30	83.45	82.04	81.54
	Dissolved Manganese (ug/L)	3 Month	132.43	250.00	137.65	137.52	137.50	142.07	139.04	137.99
		6 Month	82.61	250.00	96.77	96.44	96.37	107.86	100.34	97.65
	Hardness (mg/L)	3 Month	50.00	40.00	49.56	49.57	49.57	49.18	49.44	49.53
		6 Month	50.00	47.67	49.80	49.81	49.81	49.65	49.75	49.79
	Total Dissolved Solids (mg/L)	3 Month	130.46	138.60	130.82	130.81	130.81	131.13	130.92	130.85
		6 Month	131.71	138.41	132.28	132.26	132.26	132.72	132.42	132.31
	Total Organic Carbon (mg/L)	3 Month	6.94	8.63	7.02	7.01	7.01	7.08	7.04	7.02
		6 Month	6.91	8.50	7.05	7.04	7.04	7.15	7.08	7.05
	pH	3 Month	8.20	7.65						
		6 Month	8.10	7.55						
Nutrient Parameters	Chlorophyll-A (ug/L)	3 Month	34.07	42.83	34.46	34.45	34.45	34.79	34.56	34.48
		6 Month	30.21	39.39	30.98	30.97	30.96	31.59	31.18	31.03
	Dissolved Oxygen (mg/L)	3 Month	5.56	5.26	5.55	5.55	5.55	5.54	5.55	5.55
		6 Month	6.21	5.51	6.15	6.15	6.15	6.11	6.14	6.15
	Nitrite + Nitrate (mg/L)	3 Month	0.03	0.38	0.05	0.05	0.05	0.06	0.05	0.05
		6 Month	0.07	0.42	0.10	0.10	0.10	0.12	0.11	0.10
	Orthophosphate Phosphorus (mg/L)	3 Month	0.04	0.06	0.04	0.04	0.04	0.04	0.04	0.04
		6 Month	0.03	0.06	0.04	0.04	0.04	0.04	0.04	0.04
	Total Phosphorus (mg/L)	3 Month	0.11	0.08	0.11	0.11	0.11	0.11	0.11	0.11
		6 Month	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
	Secchi Depth (m)	3 Month	0.76	0.82						
		6 Month	0.78	0.77						
	Temperature (°C)	3 Month	28.63	28.20						
		6 Month	26.72	26.04						

Table 5-4
Water Quality Concentrations in Richland-Chambers Reservoir with the Inclusion of 102 MGD of Lake Palestine Water

					Richland-Chambers Historical Volume by Percentile (acre-feet)			Richland-Chambers Volume by Percentage of Conservation Storage (acre-feet)		
					50th	75th	90th	50%	75%	90%
					1,110,070	1,138,876	1,154,625	568,300	852,450	1,022,940
	Parameter	Background Concentrations			Richland-Chambers Parameter Concentrations after Blending 102 MGD of Lake Palestine Water					
		Time Period	Richland - Chambers	Palestine						
Treatability Parameters	Alkalinity (mg/L)	3 Month	86.25	37.50	85.02	85.05	85.07	83.90	84.66	84.92
		6 Month	90.51	37.85	87.92	87.99	88.02	85.69	87.19	87.71
	Dissolved Iron (ug/L)	3 Month	33.91	110.00	35.84	35.79	35.76	37.58	36.40	36.00
		6 Month	40.53	110.00	43.94	43.85	43.81	46.89	44.90	44.21
	Dissolved Manganese (ug/L)	3 Month	35.64	250.00	41.06	40.93	40.86	45.98	42.65	41.51
		6 Month	30.62	250.00	41.38	41.12	40.99	50.71	44.43	42.25
	Hardness (mg/L)	3 Month	95.00	40.00	93.61	93.64	93.66	92.35	93.20	93.49
		6 Month	95.00	47.67	92.68	92.73	92.76	90.67	92.02	92.49
	Total Dissolved Solids (mg/L)	3 Month	153.48	138.60	153.11	153.12	153.12	152.77	153.00	153.08
		6 Month	159.36	138.41	158.33	158.36	158.37	157.44	158.04	158.25
	Total Organic Carbon (mg/L)	3 Month	5.39	8.63	5.48	5.47	5.47	5.55	5.50	5.48
		6 Month	5.41	8.50	5.57	5.56	5.56	5.70	5.61	5.58
	pH	3 Month	8.10	7.65						
		6 Month	8.07	7.55						
Nutrient Parameters	Chlorophyll-A (ug/L)	3 Month	21.10	42.83	21.65	21.64	21.63	22.15	21.81	21.69
		6 Month	20.98	39.39	21.89	21.86	21.85	22.67	22.14	21.96
	Dissolved Oxygen (mg/L)	3 Month	4.85	5.26	4.86	4.86	4.86	4.87	4.86	4.86
		6 Month	5.48	5.51	5.48	5.48	5.48	5.48	5.48	5.48
	Nitrite + Nitrate (mg/L)	3 Month	0.03	0.38	0.03	0.03	0.03	0.04	0.04	0.04
		6 Month	0.06	0.42	0.07	0.07	0.07	0.09	0.08	0.08
	Orthophosphate Phosphorus (mg/L)	3 Month	0.02	0.06	0.02	0.02	0.02	0.02	0.02	0.02
		6 Month	0.01	0.06	0.02	0.02	0.02	0.02	0.02	0.02
	Total Phosphorus (mg/L)	3 Month	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
		6 Month	0.08	0.10	0.08	0.08	0.08	0.08	0.08	0.08
	Secchi Depth (m)	3 Month	0.93	0.82						
		6 Month	0.88	0.77						
	Temperature (°C)	3 Month	27.80	28.20						
		6 Month	26.11	26.04						

Table 5-5
Water Quality Concentrations in Joe Pool Lake with the Inclusion of 102 MGD of Lake Palestine Water

					Joe Pool Historical Volume by Percentile (acre-feet)			Joe Pool Volume by Percentage of Conservation Storage (acre-feet)		
					50th	75th	90th	50%	75%	90%
					176,074	178,844	184,316	88,448	132,671	159,206
		Background Concentrations			Joe Pool Parameter Concentrations after Blending 102 MGD of Lake Palestine Water					
	Parameter	Time Period	Joe Pool	Palestine						
Treatability Parameters	Alkalinity (mg/L)	3 Month	102.69	37.50	93.53	93.65	93.88	86.68	91.07	92.71
		6 Month	106.04	37.85	89.30	89.50	89.87	79.24	85.48	88.00
	Dissolved Iron (ug/L)	3 Month	67.74	110.00	73.68	73.60	73.45	78.12	75.28	74.22
		6 Month	59.02	110.00	71.54	71.39	71.11	79.06	74.40	72.51
	Dissolved Manganese (ug/L)	3 Month	103.77	250.00	124.32	124.05	123.53	139.68	129.85	126.17
		6 Month	90.48	250.00	129.64	129.18	128.30	153.18	138.59	132.69
	Hardness (mg/L)	3 Month	149.38	40.00	134.00	134.21	134.60	122.51	129.87	132.62
		6 Month	153.17	47.67	127.27	127.57	128.15	111.70	121.35	125.25
	Total Dissolved Solids (mg/L)	3 Month	318.88	138.60	293.54	293.87	294.52	274.60	286.72	291.26
		6 Month	312.55	138.41	269.80	270.30	271.26	244.10	260.04	266.47
	Total Organic Carbon (mg/L)	3 Month	4.05	8.63	4.69	4.69	4.67	5.18	4.87	4.75
		6 Month	4.76	8.50	5.68	5.67	5.65	6.23	5.89	5.75
	pH	3 Month	8.08	7.65						
		6 Month	8.13	7.55						
Nutrient Parameters	Chlorophyll-A (ug/L)	3 Month	6.85	42.83	11.91	11.84	11.71	15.69	13.27	12.36
		6 Month	6.85	39.39	14.84	14.75	14.57	19.64	16.66	15.46
	Dissolved Oxygen (mg/L)	3 Month	6.39	5.26	6.23	6.23	6.23	6.11	6.19	6.21
		6 Month	7.22	5.51	6.80	6.80	6.81	6.55	6.70	6.77
	Nitrite + Nitrate (mg/L)	3 Month	0.06	0.38	0.10	0.10	0.10	0.14	0.12	0.11
		6 Month	0.08	0.42	0.16	0.16	0.16	0.21	0.18	0.17
	Orthophosphate Phosphorus (mg/L)	3 Month	0.02	0.06	0.02	0.02	0.02	0.03	0.02	0.02
		6 Month	0.02	0.06	0.03	0.03	0.03	0.03	0.03	0.03
	Total Phosphorus (mg/L)	3 Month	0.03	0.08	0.04	0.04	0.04	0.04	0.04	0.04
		6 Month	0.06	0.10	0.07	0.07	0.07	0.08	0.07	0.07
	Secchi Depth (m)	3 Month	1.07	0.82						
		6 Month	1.03	0.77						
	Temperature (°C)	3 Month	28.73	28.20						

Because water quality data were not available for the field-scale wetland system for all of the parameters included in this analysis, **Table 5-3** and **Table 5-4** do not include the addition of the future Cedar Creek and Richland-Chambers constructed wetland systems. A separate analysis of only the parameters available in the wetlands data was performed to show the addition of the wetland systems and the results are shown in **Table 5-6** and **Table 5-7**. Under CA 08-4976C, TRWD may divert 88,059 ac-ft/yr at a maximum rate of 156.6 cfs from the Cedar Creek wetland system to Cedar Creek Reservoir. Under CA 08-5035C, TRWD may divert 100,465 ac-ft/yr or a maximum of 11,398 ac-ft/month from the Richland-Chambers wetland system to Richland - Chambers Reservoir. The impact of including the Richland-Chambers and Cedar Creek wetland systems was evaluated at their maximum monthly diversion rate over a 3 and 6 month time period.

Table 5-6
Water Quality Concentrations in Cedar Creek Reservoir with Wetland Effluent and the Inclusion of 102 MGD of Lake Palestine Water

						Cedar Creek Historical Volume by Percentile (acre-feet)			Cedar Creek Volume by Percentage of Conservation Storage (acre-feet)		
						50th	75th	90th	50%	75%	90%
						619,743	636,241	639,596	322,393	483,589	580,307
	Parameter	Background Concentrations Time Period	Cedar Creek	Wetland	Palestine	Cedar Creek Parameter Concentrations after Blending Wetland Effluent and 102 MGD of Lake Palestine Water					
Treatability Parameters	Alkalinity (mg/L)	3 Month	59.59	121.26	37.50	61.25	61.21	61.20	62.55	61.67	61.35
		6 Month	61.82	113.02	37.85	63.92	63.87	63.86	65.35	64.40	64.04
	Dissolved Iron (ug/L)	3 Month	26.14	---	110.00						
		6 Month	78.73	---	110.00						
	Dissolved Manganese (ug/L)	3 Month	132.43	---	250.00						
		6 Month	82.61	---	250.00						
	Hardness (mg/L)	3 Month	50.00	171.96	40.00	54.72	54.61	54.59	58.42	55.91	55.01
		6 Month	50.00	167.41	47.67	58.91	58.72	58.68	64.98	60.94	59.42
	Total Dissolved Solids (mg/L)	3 Month	130.46	---	138.60						
		6 Month	131.71	---	138.41						
	Total Organic Carbon (mg/L)	3 Month	6.94	---	8.63						
		6 Month	6.91	---	8.50						
	pH	3 Month	8.20	---	7.65						
		6 Month	8.10	---	7.55						
Nutrient Parameters	Chlorophyll-A (ug/L)	3 Month	34.07	---	42.83						
		6 Month	30.21	---	39.39						
	Dissolved Oxygen (mg/L)	3 Month	5.56	---	5.26						
		6 Month	6.21	---	5.51						
	Nitrite + Nitrate (mg/L)	3 Month	0.03	0.11	0.38	0.05	0.05	0.05	0.06	0.05	0.05
		6 Month	0.07	0.20	0.42	0.11	0.11	0.11	0.13	0.12	0.11
	Orthophosphate Phosphorus (mg/L)	3 Month	0.04	0.82	0.06	0.08	0.08	0.08	0.10	0.08	0.08
		6 Month	0.03	0.60	0.06	0.08	0.08	0.08	0.11	0.09	0.08
	Total Phosphorus (mg/L)	3 Month	0.11	0.81	0.08	0.14	0.14	0.14	0.16	0.15	0.14
		6 Month	0.10	0.61	0.10	0.14	0.14	0.14	0.17	0.15	0.15
	Secchi Depth (m)	3 Month	0.76	---	0.82						
		6 Month	0.78	---	0.77						
	Temperature (°C)	3 Month	28.63	---	28.20						
		6 Month	26.72	---	26.04						

Table 5-7
Water Quality Concentrations in Richland-Chambers Reservoir with Wetland Effluent and the Inclusion of 102 MGD of Lake Palestine Water

						Richland-Chambers Volume by Percentile (acre-feet)			Richland-Chambers Volume by Percentage of Conservation Storage (acre-feet)		
						50th	75th	90th	50%	75%	90%
						1,110,070	1,138,876	1,154,625	568,300	852,450	1,022,940
		Background Concentrations				Richland-Chambers Parameter Concentrations after Blending Wetland Effluent and 102 MGD of Lake Palestine Water					
	Parameter	Time Period	Richland-Chambers	Wetland	Palestine						
Treatability Parameters	Alkalinity (mg/L)	3 Month	86.25	121.26	37.50	86.08	86.08	86.08	85.92	86.03	86.06
		6 Month	90.51	113.02	37.85	89.31	89.34	89.35	88.38	89.00	89.22
	Dissolved Iron (ug/L)	3 Month	33.91	---	110.00						
		6 Month	40.53	---	110.00						
	Dissolved Manganese (ug/L)	3 Month	35.64	---	250.00						
		6 Month	30.62	---	250.00						
	Hardness (mg/L)	3 Month	95.00	171.96	40.00	95.89	95.87	95.86	96.66	96.14	95.96
		6 Month	95.00	167.41	47.67	96.81	96.77	96.75	98.23	97.29	96.95
	Total Dissolved Solids (mg/L)	3 Month	153.48	---	138.60						
		6 Month	159.36	---	138.41						
	Total Organic Carbon (mg/L)	3 Month	5.39	---	8.63						
		6 Month	5.41	---	8.50						
	pH	3 Month	8.10	---	7.65						
		6 Month	8.07	---	7.55						
Nutrient Parameters	Chlorophyll-A (ug/L)	3 Month	21.10	---	42.83						
		6 Month	20.98	---	39.39						
	Dissolved Oxygen (mg/L)	3 Month	4.85	---	5.26						
		6 Month	5.48	---	5.51						
	Nitrite + Nitrate (mg/L)	3 Month	0.03	0.11	0.38	0.04	0.04	0.04	0.05	0.04	0.04
		6 Month	0.06	0.20	0.42	0.08	0.08	0.08	0.10	0.09	0.08
	Orthophosphate Phosphorus (mg/L)	3 Month	0.02	0.82	0.06	0.04	0.04	0.04	0.06	0.05	0.04
		6 Month	0.01	0.60	0.06	0.05	0.05	0.05	0.08	0.06	0.05
	Total Phosphorus (mg/L)	3 Month	0.08	0.81	0.08	0.11	0.10	0.10	0.12	0.11	0.11
		6 Month	0.08	0.61	0.10	0.11	0.11	0.11	0.13	0.12	0.11
Secchi Depth (m)		3 Month	0.93	---	0.82						
		6 Month	0.88	---	0.77						
Temperature (°C)		3 Month	27.80	---	28.20						
		6 Month	26.11	---	26.04						

5.3 Environmental Water Quality Evaluation Results

The impact on each receiving reservoir was evaluated under volume conditions equal to the 50th, 75th, and 90th percentile of historical volume and at 50%, 75%, and 90% of the conservation storage capacity. The historical water quality concentrations and calculated concentrations from the mass balance for the reservoirs and the wetland system were evaluated and the results are presented below.

As noted in the 2006 Region C Water Plan, in general, East Texas reservoirs such as Lake Palestine have higher concentrations of nutrients than the evaluated receiving reservoirs discussed below. The Region C Water Plan notes that all of the water management strategies involving importation of water from East Texas were considered to have "low" or "medium-low" impacts on key water quality parameters.

5.3.1 Lake Benbrook

Although not considered to be a highly probable operational scenario, directly blending 102 MGD of Lake Palestine water with Lake Benbrook would have the following impacts:

- An increase to dissolved iron, dissolved manganese, nitrite + nitrate, and orthophosphate phosphorus concentrations in Lake Benbrook;
- Lesser impact to alkalinity, total organic carbon, chlorophyll-A, and total phosphorus; and
- Improvement to hardness and total dissolved solids concentrations with the addition of Lake Palestine water.

5.3.2 Cedar Creek Reservoir

Blending 102 MGD of Lake Palestine water with Cedar Creek Reservoir would have the following impacts:

- An increase to the nitrite + nitrate concentration in Cedar Creek Reservoir;
- Lesser impact to alkalinity, dissolved iron, dissolved manganese, chlorophyll-A, and orthophosphate phosphorus; and
- Negligible impacts, both positive and negative, to hardness, total dissolved solids, total organic carbon, and total phosphorus.

With the inclusion of the wetland system and the blending of Lake Palestine water: nitrite + nitrate, orthophosphate phosphorus would increase from the historical concentration levels. Hardness would also increase from the historical concentration but to a lesser degree. Alkalinity will improve with the inclusion of the wetland system and the blending of Lake Palestine water.

5.3.3 Richland-Chambers Reservoir

Blending 102 MGD of Lake Palestine water with Richland-Chambers Reservoir would have the following impacts:

- An increase to the dissolved manganese and nitrite + nitrate concentration in Richland-Chambers Reservoir;
- Lesser negative impact to alkalinity, dissolved iron, total organic carbon, chlorophyll-A, and orthophosphate phosphorus;
- Improvement to the hardness in Richland-Chambers Reservoir with the addition of Lake Palestine water; and
- Negligible impacts, both positive and negative, to total dissolved solids and total phosphorus.

With the inclusion of the wetland system and the blending of Lake Palestine water nitrite + nitrate, orthophosphate phosphorus, and the total phosphorus would increase from the historical concentration. The negative impact to alkalinity and hardness from the historical concentration would be negligible with the inclusion of the wetland system and the blending of Lake Palestine water.

5.3.4 Joe Pool Lake

Blending 102 MGD of Lake Palestine water with Joe Pool Lake would:

- Increase dissolved manganese, chlorophyll-A, nitrite + nitrate, and orthophosphate phosphorus concentrations in Joe Pool Lake
- Negatively impact, though to a lesser extent, alkalinity, dissolved iron, total organic carbon, and total phosphorus; and
- Improve hardness and total dissolved solids concentrations with the addition of Lake Palestine water.

Section 6
Water Treatment Considerations

Blending TRWD and DWU raw water supplies would impact raw water quality and potentially the treatment requirements at water treatment plants that receive raw water from these entities. The purpose of this raw water treatment review and treatability analysis was to consider several potential scenarios of blending and transmission that would cause water quality changes that may require modifications to the existing water treatment plant processes.

The four project conveyance alternatives, described in **Table 1-1**, are reproduced below for the reader's convenience.

Alternative	Description
1 (Baseline)	Independent Systems: TRWD's East Texas Third Pipeline and DWU's connection of Lake Palestine to the proposed Southeast Water Treatment Plant
2 (Baseline)	Independent Systems: TRWD's East Texas Third Pipeline and DWU's connection of Lake Palestine to Joe Pool Lake
3 (Interconnection)	Integrated System: Interconnected Third Pipeline (upsized as compared to the baseline condition) with connection of Lake Palestine to Cedar Creek Reservoir and delivery to DWU at Joe Pool Lake and TRWD's customers through the Third Pipeline
4 (Interconnection)	Integrated System: Interconnected "Southern Pipeline" - Lake Palestine delivered to the Lake Benbrook area via a pipeline route to the south of the TRWD Third Pipeline route. Delivery to DWU at Joe Pool Lake and TRWD's customers through connections to the existing system and the Lake Benbrook pipeline.

In the two Baseline alternatives, TRWD would continue to provide raw water to its customer treatment facilities and DWU would deliver raw water to either the proposed Southeast Water Treatment Plant or to the Joe Pool Lake vicinity, for treatment nearby at a new water treatment plant or at the Dallas Bachman WTP. This is also the case for the two Interconnection alternatives with the exception that it was assumed DWU would deliver raw water only to the Joe Pool Lake area for treatment nearby at a new facility or at the Dallas Bachman WTP.

Due to the unlimited possible combinations of source water blends, this treatment evaluation confined the assumed blends to Lake Palestine water discharged solely into one of the four reservoirs: Richland-Chambers, Cedar Creek, Joe Pool or Benbrook. It was further assumed that water supplied from Richland-Chambers Reservoir and Cedar Creek Reservoir would be blended at a 2:1 ratio, similar to typical existing operations.

6.1 Water Quality Parameters of Concern

Raw water quality parameters that could impact treatment processes primarily include alkalinity, hardness, total organic carbon (TOC), total dissolved solids (TDS), bromide, iron, and manganese. The potential impacts of each of these parameters are discussed below.

Alkalinity. Alkalinity is a measure of water's ability to neutralize acid - its buffering capability. Waters with low alkalinity are typically more difficult to treat. Lower alkalinity waters will also require additional TOC reduction per the EPA Stage 1 Disinfectants/Disinfection Byproduct Rule (D/DBPR). Low alkalinity waters would also impact the design of, and materials used in, the transmission systems.

Hardness. Waters with high levels of hardness may require implementation of a softening process at the treatment plant. Such processes are more costly to construct and operate than conventional plants. For example, lime softening process produces significantly greater amounts of sludge that must be handled. Hardness levels are not a concern for any of the TRWD or DWU raw water supplies and were therefore assumed to not be an issue in this evaluation.

Total Organic Carbon. TOC levels have a direct impact on disinfection byproduct (DBP) formation. Raw water with a higher concentration of TOC will result in greater formation of regulated DBPs. Although TOC is not specifically regulated, a certain percentage of TOC reduction is required by the D/DBPR, and higher levels of raw water TOC require higher rates of TOC reduction.

Total Dissolved Solids. TDS is a measure of the concentration of minerals in the water. The Federal Secondary Standard for TDS is 500 mg/L and the TCEQ Secondary Standard is 1000 mg/L. Raw water supplies with TDS levels higher than the secondary standards would require higher-level treatment processes, such as reverse osmosis. TDS levels are not a problem for any of the TRWD or DWU raw water supplies and were not considered in this evaluation.

Bromide. Although Bromide is not a regulated parameter, its presence in raw water, can trigger a reaction with ozone to form bromate, a regulated compound. If the bromate concentration exceeds 10 ug/L, control techniques must be implemented, applied ozone dose reduced, or the ozonation process removed. Most of the WTPs that would be impacted by the interconnection of the raw water transmission system use ozonation as part of the treatment process.

Iron and Manganese. Iron and manganese are metals primarily associated with aesthetic water quality concerns, such as metallic tastes and staining of plumbing fixtures and laundry. Iron and manganese are regulated as secondary standards, with maximum levels of 0.3 mg/L and 0.05 mg/L respectively. Waters with higher levels of iron and manganese require removal, typically oxidation by aeration or with chlorine dioxide or permanganate. Ozone will also oxidize iron and manganese, but would typically not be added specifically for this purpose.

6.2 Reservoir Water Quality

Water quality parameters for the various reservoirs are summarized in Section 5. For purposes of this treatability analysis, the six month average water quality data between June and November were used. The reservoir water quality data are summarized below in **Table 6-1**.

Table 6-1
Reservoir Water Quality

Water Quality Parameter	Lake Palestine	Cedar Creek Reservoir	Richland-Chambers Reservoir	Lake Benbrook	Joe Pool Lake	Elm Fork Trinity River
Alkalinity (mg/L)	38	62	91	107	106	110
Hardness (mg/L)	48	50	95	140	153	140
TOC (mg/L)	8.5	6.9	5.4	5.3	4.8	5.0
TDS (mg/L)	138	132	159	189	313	N/A
Bromide (mg/L)	0.12	0.09	0.09	0.12	N/A	0.13
Iron (ug/L)	110	79	41	23	59	<100
Manganese (ug/L)	250	83	31	25	90	N/A

The Baseline and Interconnected water supply alternatives would result in changes to water quality that differ from the current raw water supplies provided to the TRWD customer water treatment plants and the DWU Bachman water treatment plant. This analysis used the blended water quality data presented in the Espey Consultants May, 2008 technical memorandum and used the **50th percentile reservoir volume** scenarios. A summary of water quality for each alternative is presented below.

6.3 DWU Water Treatment Considerations, Baseline Alternatives 1 and 2

The Baseline alternatives include taking raw water either directly from Lake Palestine to a new Southeast Water Treatment Plant (SEWTP) (Alternative 1), or taking Lake Palestine water to Joe Pool Lake for treatment at a new treatment plant nearby or at the Bachman WTP (Alternative 2). Therefore, in Baseline Alternative 1 water quality at the proposed SEWTP would be the same as Lake Palestine water quality. In Baseline Alternative 2, it was assumed that water would be taken from the pipeline prior to discharging into Joe Pool Lake. Therefore, water quality at a new treatment plant at Joe Pool Lake, or at the Bachman WTP, would be the same as Lake Palestine water.

Table 6-2 presents calculated water quality delivered to Dallas water treatment plants for these two Baseline alternatives and, for comparative purposes, the current raw water quality at the Bachman WTP.

Table 6-2
Water Quality with Implementation of DWU Baseline Alternative

Water Quality Parameter	SEWTP, New WTP near Joe Pool Lake, and Bachman WTP from Lake Palestine	Lake Palestine/Joe Pool Lake Blend (1)	Current Bachman Raw From Trinity River
Alkalinity (mg/L)	38	89	110
Hardness (mg/L)	48	127	140
TOC (mg/L)	8.5	5.7	5.0
TDS (mg/L)	138	270	
Bromide (mg/L)	0.12	–	0.13
Iron (ug/L)	110	72	<100
Manganese (ug/L)	250	130	

Note (1): The water quality blend illustrated in this column would only be applicable to a new water treatment plant near Joe Pool Lake or the Bachman WTP if a blend of Lake Palestine and Joe Pool Lake waters were used.

6.4 TRWD Water Treatment Considerations, Baseline Alternatives 1 and 2

For TRWD, Baseline Alternatives 1 and 2 include adding a Third Pipeline to carry raw water from Cedar Creek and Richland-Chambers Reservoirs (including water supply augmentation from the constructed wetlands) to its customers. TRWD would continue to use Lake Benbrook as terminal storage, primarily for the Fort Worth Rolling Hills WTP and future Westside WTP. Under the baseline alternatives, TRWD customers would not see a significant change in the water treatment parameters. **Table 6-3** presents potential water quality blends delivered to TRWD customer water treatment plants for the Baseline Alternatives 1 and 2. The Richland-Chambers/Cedar Creek blend was assumed to be a 2:1 blend ratio.

Table 6-3
Water Quality with Implementation of TRWD Baseline Alternative

Water Quality Parameter	Cedar Creek Reservoir	Richland-Chambers Reservoir	Cedar Creek/ Richland-Chambers Blend	Lake Benbrook
Alkalinity (mg/L)	62	91	81	107
Hardness (mg/L)	50	95	80	140
TOC (mg/L)	6.9	5.4	5.9	5.3
TDS (mg/L)	132	159	154	189
Bromide (mg/L)	0.09	0.09	0.09	0.12
Iron (ug/L)	79	41	54	23
Manganese (ug/L)	83	31	48	25

6.5 Interconnection Alternative 3 Water Treatment Considerations – Lake Palestine to Cedar Creek Reservoir

Under this Interconnection alternative, Lake Palestine water would be pumped to Cedar Creek Reservoir. The Lake Palestine/Cedar Creek blend may then be combined with Richland-Chambers water in the transmission system before delivery to TRWD customers and before delivery to DWU at Joe Pool Lake (for treatment nearby at a new WTP or at Bachman WTP). For this analysis, the raw water was assumed to be a 2:1 blend of water originating from Richland-Chambers Reservoir and Cedar Creek Reservoir (including Lake Palestine). **Table 6-4** presents potential water quality delivered through the interconnected system for this alternative.

Table 6-4
Water Quality with Delivery of Lake Palestine to Cedar Creek

Water Quality Parameter	Lake Palestine	Cedar Creek Reservoir	Lake Palestine/ Cedar Creek Blend	Richland-Chambers Reservoir	Cedar Creek/ Richland-Chambers Blend
Alkalinity (mg/L)	38	62	60	91	81
Hardness (mg/L)	48	50	50	95	80
TOC (mg/L)	8.5	6.9	7.0	5.4	5.9
TDS (mg/L)	138	132	132	159	150
Bromide (mg/L)	0.12	0.09	–	0.09	–
Iron (ug/L)	110	79	81	41	54
Manganese (ug/L)	250	83	97	31	53

6.6 Interconnection Alternative 4 Water Treatment Considerations – Lake Palestine to Lake Benbrook

Under this Interconnection alternative (the "southern pipeline"), Lake Palestine water could be pumped directly to the Lake Benbrook area bypassing Richland-Chambers and Cedar Creek during certain system operations. The Lake Palestine water could then be supplied to the Fort Worth Rolling Hills WTP and Westside WTP. Prior to reaching the Lake Benbrook area, Lake Palestine water could also supply the future Fort Worth Southwest WTP. All three of these plants could also be supplied from Cedar Creek Reservoir and Richland-Chambers Reservoir which would include blends of Lake Palestine and constructed wetlands waters. Other TRWD customers would continue to receive water directly from Richland-Chambers and Cedar Creek Reservoirs through the existing TRWD transmission pipelines.

Lake Palestine water from the southern pipeline would also be provided to the Joe Pool Lake area to supply the Bachman WTP or other new treatment facilities. The potential delivery of Lake Palestine water directly to the Lake Benbrook area is considered to be an infrequent possibility since it assumes the direct transfer of unblended Lake Palestine water to the outermost edge of the study area. Nevertheless, it provides the most extreme blending scenario in terms of water treatment considerations for an integrated system for some of the TRWD customers.

Table 6-5 presents potential water quality delivered through Interconnection Alternative 4 for this blending scenario. It also shows the water quality if Lake Palestine water were blended with Lake Benbrook water. Due to permitting and contract issues, this is not considered a likely scenario in the foreseeable future.

Table 6-5
Water Quality with Delivery of Lake Palestine to the Lake Benbrook Area

Water Quality Parameter	Fort Worth WTPs from Lake Palestine	Lake Benbrook	Lake Palestine/ Lake Benbrook Blend (1)
Alkalinity (mg/L)	38	107	78
Hardness (mg/L)	48	140	102
TOC (mg/L)	8.5	5.3	6.6
TDS (mg/L)	138	189	168
Bromide (mg/L)	0.12	0.12	–
Iron (ug/L)	110	23	59
Manganese (ug/L)	250	25	117

Note (1): For informational purposes. Not a likely scenario.

6.7 Treatability Issues

The Baseline and Integrated water supply alternatives present changes in raw water quality that will impact the treatment processes at the water treatment plants and could increase operational costs and potentially require additional capital expenditures. A discussion of the treatability issues for each project conveyance alternative follows.

6.7.1 Baseline Alternatives

Under Baseline Alternatives 1 and 2, WTPs currently receiving raw water from TRWD would continue to receive water delivered from Richland-Chambers Reservoir and Cedar Creek Reservoir, both of which would also include constructed wetlands augmentation in the future. The Fort Worth Rolling Hills WTP and future Westside WTP would also continue to receive water from Lake Benbrook under seasonal operational scenarios. No impact to water quality or treatability related to Lake Palestine would occur under this scenario.

Under Baseline Alternatives 1 and 2, either the proposed DWU Southeast WTP, new WTP near Joe Pool Lake, or the Bachman WTP would receive raw water directly from Lake Palestine. This water quality would be significantly different from the Elm Fork of the Trinity River raw water currently supplied to the Bachman WTP. The DWU WTPs could expect the following water quality and treatability issues under Alternatives 1 and 2:

- The raw water alkalinity would be less than 60 mg/L, limiting the raw water's buffering capability and making it more difficult to treat. The TOC would be above 8.0 mg/L, meaning that 50% of the TOC must be removed during the treatment process or an alternative minimum TOC removal requirement must be implemented. The proposed SEWTP could expect to use greater amounts of coagulant than those currently used at the Bachman WTP. Bench scale studies would be required to determine the actual amounts of coagulant required.

- The high levels of TOC raise the potential for high levels of disinfection byproduct (DBP) formation. If ozonation were to be used as the primary disinfectant (as at the Bachman WTP) and chloramine as the residual disinfectant, the plant should be able to control DBPs successfully.

- Iron levels from Lake Palestine water are somewhat elevated, but fall within the regulatory secondary standards. Plants utilizing ozone or chlorine dioxide would oxidize some of the iron, thereby reducing the iron content in the finished water.

- Manganese levels from Lake Palestine are well above the regulatory secondary drinking water standards. These manganese levels could be reduced to below the regulatory standards through oxidation with ozone, if it were applied similar to methods used at the Bachman WTP. However, care would be required to limit the potential for conversion of the manganese to permanganate, which could result in pink water. The use of biological filtration following the ozonation process has shown to be effective for manganese reduction. It is anticipated that approximately 0.25 mg/L of additional ozone dose would be required to provide the desired manganese oxidation. This would be in addition to the dosage required for disinfection and taste and odor control.

If under Baseline Alternative 2 the Lake Palestine water were pumped directly into Joe Pool Lake and then delivered to a new WTP near Joe Pool Lake or the Bachman WTP, the water quality parameters would be similar to current raw water quality from the Elm Fork of the Trinity River. This blending scenario was considered to provide insight into the impact of such a diversion.

- Raw water alkalinity of about 89 mg/L and TOC of 5.7 mg/L would require TOC reduction of 35%. This water would be more easily treated than the raw water directly from Lake Palestine.

- The TOC would be in line with current levels and should not present significant DBP formation issues, especially with the use of ozone and chloramine for disinfection.

- Manganese levels would still be elevated, although less than those associated with direct use of Lake Palestine water. The additional dose of ozone required for oxidation of manganese would be approximately 0.1 mg/L.

Treatability issues related to the Baseline alternatives would result in little impact to the TRWD customers, but would impact the DWU plants (and possibly any other water treatment plants using Joe Pool Lake in one alternative). Sending Lake Palestine raw water directly to the proposed Southeast WTP, Bachman WTP, or a new WTP near Joe Pool would have the greatest impact on the cost of operating the plant and meeting regulatory requirements.

6.7.2 Interconnection Alternative 3 / Water Treatment Scenario 1 – Lake Palestine to Cedar Creek Reservoir

Under this scenario, the blended Lake Palestine and Cedar Creek Reservoir raw water would be similar to the Cedar Creek raw water currently being provided to the TRWD customers. The only constituent of potential concern in this blend, related to water treatment, is manganese. However, as discussed above in the Baseline alternatives, oxidation with ozone would be an effective treatment process for reducing the manganese level. Minimal (if any) additional ozone would be required to oxidize the manganese. The Mansfield WTP does not use ozonation as part of its treatment process. However, it does use chlorine dioxide, which is at least as effective as ozone in oxidizing manganese.

Also under this scenario, the DWU Bachman WTP or new plant near Joe Pool Lake would be provided with the same water quality as the TRWD plants from the Third Pipeline. This water quality would be similar to the DWU Baseline Alternatives 1 and 2 discussed in Section 6.4, and the same water quality and treatment issues apply.

6.7.3 Interconnection Alternative 4 / Water Treatment Scenario 2 – Lake Palestine to Lake Benbrook

Under this worst case, low probability operational scenario, raw water from Lake Palestine would feed the Fort Worth Rolling Hills WTP and future Westside WTP. The Lake Palestine water would be similar to the more difficult Cedar Creek Reservoir water that the Rolling Hills WTP sometimes receives, except for the elevated iron and manganese levels. The treatability issues would be the same as those presented in the DWU Baseline alternative with low alkalinity, high TOC and elevated manganese levels. Additional coagulation chemicals would likely be required to treat this water. The ozonation process, in place at the Rolling Hills WTP, should oxidize the manganese for removal in the sedimentation and biological filtration processes of the plant. Under this scenario, the future Fort Worth Southwest WTP could also receive Lake Palestine raw water directly from the Southern Pipeline.

6.8 Summary and Conclusions

Integrating Lake Palestine water into the DWU and TRWD raw water supply systems would have a low to moderate impact on water quality and treatment at the existing and proposed water treatment plants. The major impacts of the Lake Palestine water relate to its low alkalinity, high TOC, and high manganese concentrations.

Implementing the Baseline alternatives would create no impact to water quality or treatability at the existing plants currently being served by TRWD since the supply sources would be the same (except for the planned implementation of the constructed wetlands project). The DWU Baseline alternative, with Lake Palestine water exclusively, would result in raw water at the proposed Southeast WTP, new WTP near Joe Pool Lake, or the Bachman WTP that is more difficult to treat when compared to the City's existing Bachman WTP. The low alkalinity would require greater amounts of coagulant for treatment. The higher TOC level would present more difficulty in meeting DBP requirements. The low alkalinity coupled with the relatively high TOC would require greater TOC reduction and most likely greater coagulant use. The high manganese levels would require greater, although not significant, ozone use for oxidation and removal of manganese. Although the Lake Palestine water is anticipated to be more difficult to treat, the overall treatment process could be similar to the current DWU plants, like Bachman WTP. The operational costs would be slightly greater due to increased ozone and coagulant requirements.

Implementing water quality scenario 1 in Interconnection Alternative 3 (described in Section 6.7.2) presents no major water quality issues that would adversely impact treatability or require significant increases in operational costs. The only constituent of concern is manganese, and it could be mitigated either through blending controls or oxidized through the current plant treatment processes.

The less probable water quality scenario 2 in Interconnection Alternative 4 (described in Section 6.7.3) results in the least favorable water quality for TRWD customer plants and presents the most treatability concerns of the integrated water quality scenarios and is provided as a "worst" case. The Fort Worth Rolling Hills and Westside WTPs could seasonally be provided with water with low alkalinity, high TOC, and relatively high manganese levels. Although the ozonation processes at both plants would oxidize the manganese, it would require closer management to effectively monitor and control the process and would result in greater costs for operation. This water quality scenario also could provide the proposed Fort Worth Southwest WTP with Lake Palestine raw water.

Section 7
Permitting and Regulatory Review

7.1 Introduction

This section presents a summary of the water rights and regulatory considerations for the various facilities considered in this Project Viability Assessment and as such represents a "fatal flaw" and due diligence review for this conceptual analysis.

7.2 Water Rights

7.2.1 Lake Palestine

- The Lake Palestine water right fully authorizes the interbasin transfer of up to a total of 132,337 ac-ft/yr from the Neches River Basin into the Trinity River Basin for municipal and industrial use, with no restrictions on where the water can be used or by whom.

- Any water diverted to the Trinity River Basin from the 18,000 ac-ft/yr of industrial water that is authorized for diversion from the Downstream Diversion Reservoir under the Lake Palestine water right that is not consumed must be returned "to an unnamed tributary of Cedar Creek, tributary of Trinity River" to one of two locations specified in Paragraph 7 of the Certificate of Adjudication. This means that most, if not all, of the diversions to the Trinity River Basin under the Lake Palestine water right should come from Lake Palestine.

- The maximum diversion rate for diversions from Lake Palestine is 518 cfs, which may limit how much water can be diverted to the Trinity River Basin when considered with other diversions that are made from the reservoir for other water users and customers of the Upper Neches River Municipal Water Authority.

- The priority dates for the interbasin transfer of water from Lake Palestine to the Trinity River Basin are relatively junior (1972 and 1983), compared to the primary priority date for impounding and using water in Lake Palestine (1956).

- None of the existing reservoirs in the Trinity River Basin being considered as potential terminal storage reservoirs for the Lake Palestine water are currently authorized for such storage, including Cedar Creek Reservoir, Richland-Chambers Reservoir, Lake Benbrook, Eagle Mountain Lake, and Joe Pool Lake.

- Lake Benbrook on the Trinity River Clear Fork and Eagle Mountain Lake on the Trinity River West Fork are authorized to store water delivered from Cedar Creek and Richland-Chambers Reservoirs.

- New water rights permits or amendments to existing reservoir water rights in the Trinity River Basin will be required to authorize the storage and use of Lake Palestine water by the City of Dallas and the Tarrant Regional Water District.

- The use of Joe Pool Lake for terminal storage of the Lake Palestine water will require contractual agreements with the U. S. Army Corps of Engineers (reservoir owner) and the Trinity River Authority (water right owner).

- The use of natural stream courses for conveying Lake Palestine water to storage reservoirs or end users in the Trinity River Basin will require "bed and banks" permits from the Texas Commission on Environmental Quality.

- Authorization for the indirect reuse of return flows from the use of Lake Palestine water for municipal or industrial purposes will need to be included in water rights permits associated with the Project.

7.2.2 Cedar Creek Reservoir

- Cedar Creek Reservoir is authorized to receive water from the TRWD constructed wetlands project. This indirect reuse project to naturally treat wastewater return flows is expected to add 52,500 acre-feet per year to the reservoir.

7.2.3 Richland-Chambers Reservoir

- Richland-Chambers Reservoir is authorized to receive water from TRWD constructed wetlands like Cedar creek Reservoir, adding 63,000 acre-feet per year to Richland-Chambers.

7.2.4 Lake Arlington

- The amended certificate of adjudication (CA) for Lake Arlington indicates that the co-owners of Lake Arlington are the City of Arlington and Texas Utilities Electric Company. It is our understanding that the CA has been assigned from TXU US Holdings Company to ExTex LaPorte. Current ownership of the CA and the reservoir may therefore be different than indicated on the CA.

7.2.5 Lake Benbrook

- Lake Benbrook is owned by the U.S. Army Corps of Engineers and the CA is owned by TRWD which has contracted with the Corps for water supply storage. Using Lake Benbrook for terminal storage of Lake Palestine water will require approval and arrangements between the two parties. This agreement may require federal approval pursuant to the Water Supply Act.

7.2.6 Joe Pool Lake

- Joe Pool Lake is owned by the U.S. Army Corps of Engineers and the CA is owned by the Trinity River Authority. Using Joe Pool Lake for terminal storage of Lake Palestine water will require approval and arrangements between the two parties and may federal approval pursuant to the Water Supply Act. The City of Grand Prairie, City of Duncanville, Midlothian Water District, and City of Cedar Hill have contractual rights to water from Joe Pool Lake.

- **Contract/Contractual Permit/Agreement 1421**. Owned by the City of Grand Prairie. Allows diversions of 1,795 af per year for municipal and domestic uses. Issue date May 22, 1984 and priority date June 15, 1977**.**

- **Contract/Contractual Permit/Agreement 1422**. Owned by the City of Duncanville. Allows diversions of 1,197 af per year for municipal and domestic uses. Issue date May 22, 1984 and priority date June 15, 1977.

- **Contract/Contractual Permit/Agreement 1423**. Owned by the Midlothian Water District. Allows diversions of 6,662 af per year for municipal and domestic uses. Issue date May 22, 1984 and priority date June 15, 1977.

- **Contract/Contractual Permit/Agreement 1424**. Owned by the City of Cedar Hill. Allows diversions of 7,346 af per year for municipal and domestic and industrial uses. Issue date May 22, 1984 and priority date June 15, 1977.

7.3 Federal Permits

- The construction of pumping and conveyance facilities and regulating reservoirs required for delivering Lake Palestine water to the Trinity River Basin users will require a permit(s) under Section 404 of the Clean Water Act to the extent that the discharge of dredged and fill material adversely impacts United States' waters.

- The required Section 404 permit(s) may be "individual" permit(s) tailored specifically for the facilities and impacts associated with the Project or they may be "general" or "nationwide" permits provided the Project facilities and associated impacts qualify.

- Potentially available nationwide permits:

    1. No. 12 – Utility Line Construction impacting less than one-half acre of United States' water.

    2. No. 18 – Minor Discharges of Dredged or Fill Material involving less than 25 cubic yards of material and impacting less than one-tenth acre of United States' waters.

- Pipeline crossings of navigable streams as part of the Project will require a permit(s) under Section 10 of the River and Harbors Act of 1899.

- The Trinity River in the vicinity of where Project pipelines potentially would cross is classified as being navigable by the Corps of Engineers.

7.4 Application of Section 402 of the Clean Water Act to the Transfer

Section 402 of the Clean Water Act authorizes the NPDES ("National Pollutant Discharge Elimination System"). The NPDES permit program regulates point sources

of pollutant discharges into the waters of the United States. Whether transfers of water such as the envisioned interbasin transfers should be subject to Section 402 has been the subject of extensive litigation. The U.S. Supreme Court addressed this question in 2004 and found that current law requires an NPDES merely for the conveyance of a pollutant from one hydrologically distinct basin to another. *South Florida Water Management Dist. V. Miccosukee Tribe of Indians, 541 U.S. 95 (2204).* More recently, the Second Circuit Court of Appeals found that NPDES permits are required for interbasin transfers. *Catskill Mountains Chapter of Trout Unlimited, Inc. v. City of New York,* 451 F.3d 77 (2nd Cir. 2006)

The EPA subsequently proposed an amendment to the Clean Water Act regulations on June 9, 2006 that would expressly exclude water transfers (including interbasin water transfers) from regulation under the NPDES program. The EPA adopted the final rule declaring that routine transfers of water from one water body to another are not subject to NPDES permitting requirements this June 9, 2008. This rule defines a routine transfer as an activity that conveys waters without subjecting the water to intervening industrial, municipal, or commercial use. The water transfer rule codifies the former EPA interpretation that permits are not required for transfers such as routing water through tunnels, channels, or natural stream courses for public supplies, irrigation, power generation, flood control and environmental restoration. Pollutants introduced by the water transfer activity itself to the water being transferred would still be subject to permitting under the new rule.

The final rule is effective 60 days after it is published in the Federal Register, which is anticipated will be quite soon. If the rule is finalized in its present form, we do not believe a NPDES permit will be required from the Texas Commission on Environmental Quality for the transfer.

7.5 State Permits

Several state permits or agency approvals may be necessary either in conjunction with publicly-funded, or even with privately-funded, project financial sources. Publicly-funded projects often require agency coordination with key federal, state, and regional agencies. This agency coordination is usually performed in conjunction with the National Environmental Policy Act of 1969 (NEPA) and requires coordination with federal agencies and also the key state agencies introduced below. Even those projects that will not seek federal funding may also be impacted by some of the entities listed below, such as projects occurring near impaired water bodies or possibly by other means, as are described below.

- The Texas Commission on Environmental Quality (TCEQ) permitting could impact any project location if it is not adequately pre-screened through Phase I Environmental Site Assessment (ESA) investigation to verify that no contaminated air, water, or waste media are known to exist as recognized environmental conditions at a proposed site. For instance, Total Maximum Daily Load (TMDL) considerations need to be evaluated with respect to known TMDL waterways and also for those potential TMDL stream segments that are soon to be designated and

implemented, in some cases for additional parameters.

Segment 0805 Upper Trinity River, the segment that encompasses the Trinity River from near the confluence of the Elm Fork Trinity River in western Dallas County down to Cedar Creek Reservoir, is classified as impaired by PCBs (bio-accumulated in fish tissue). Segment 0805 is also under recent consideration for a potential bacterial TMDL. Some of the lakes listed above, like Joe Pool Lake and Cedar Creek Reservoir, could be affected by such regulatory action and this needs to be evaluated before any final sites are determined for an inter-basin transfer from Lake Palestine.

Segments 0805 and 0841 (Trinity River) in Dallas and Tarrant Counties are also under the TMDL project for legacy pollutants (such as chlordane, DDT, DDE, dieldrin, heptachlor epoxide, and PCBs in fish tissue) that is under implementation for the Trinity River and the Mountain Creek Lake.

- Texas Historical Commission (THC) is the home to the Texas State Preservation Office (TSPO) that is located in the Capitol Complex north of the Texas Capitol building. The THC is tasked with to preserve the historical, archaeological, architectural, and cultural resources that are protected by state and federal antiquities laws. Federally-funded and even state-funded projects will normally require that the study of proposed sites have a Phase I pedestrian archaeological investigation. At a minimum, proposed sites should have a desktop study of the THC website, to see if any listings are registered for a site or in its direct proximity.

- Texas Parks and Wildlife Department (TPWD) is the state agency that is committed to the preservation and protection of the state's floral and faunal species, in conjunction with the US Fish and Wildlife Service (USFWS). As such, TPWD typically agrees with the lead taken by USFWS for animal species; however, they take the lead for the protection of any protected plant species that might be impacted by the proposed project.

- Texas Water Development Board (TWDB) is the agency that manages the state's regional water planning program. Dallas Water Utilities and Tarrant Regional Water District are both located in Region C, the North Central Texas planning region. Lake Palestine is situated in Region I, the East Texas regional water planning group. Coordination between these Regional Water Planning groups has identified the potential inter-basin transfer of Lake Palestine water from Region I to Region C to satisfy the needs of the Dallas-Fort Worth metropolitan region as early as the Texas Water Plan 2002.

7.6 State Draft Nutrient Regulation

The Texas Commission on Environmental Quality (TCEQ) in conjunction with the U.S. Geological Service (USGS) is currently evaluating options for developing nutrient criteria for consideration by the U.S. Environmental Protection Agency (EPA) and the public during the next triennial revision of the Texas Surface Water Quality Standards (Chapter 307 in Title 30 of the Texas Administrative Code). Texas has no such numerical criteria currently but does address nutrient loadings by applying narrative criteria for permitted discharges by developing watershed rules which require nutrient reductions in wastewater discharges in or near specified water bodies, and by employing TCEQ's anti-degradation policy to increases in discharge loads of nutrients.

For assessing water bodies and regulatory actions, the TCEQ is also evaluating a "weight of evidence" approach to incorporate historical monitoring data for total phosphorous and total nitrogen for individual water bodies. The evaluation of permitted discharges could be based on screening criteria developed from historical data of all of these variables, in addition to the criteria listed in the water quality standard, such as chlorophyll *a*.

TCEQ has formed and is working with a Nutrient Criteria Development Workgroup in order to obtain stakeholder input from state and federal agencies, Texas river authorities, cities, industry, environmental groups, agricultural and other interested parties. Reservoirs have been the TCEQ staff's initial priority. Draft numerical nutrient criteria for the supply and receiving reservoirs considered in this initial viability assessment, as well as for lakes across the state, were provided to the Texas Surface Water Quality Standards Workgroup at their May 5, 2008 meeting.

Procedures to assess standards compliance with monitoring data will be established in both Section 307.9 of the *Texas Surface Water Quality Standards* and the *TCEQ Guidance for Screening and Assessing* Texas Surface Water and Finished Drinking Water Quality Data. Procedures to assess and set loading limits on nitrogen and phosphorus from regulated sources, such as permitted wastewater discharges, will be established in the TCEQ Procedures to Implement the Texas Surface Water Quality Standards.

While these nutrient regulations are still in the draft stages with TCEQ and do not currently apply to the inter-basin transfer of Lake Palestine water to the reservoirs evaluated in this study, all water supply agencies should be closely monitoring this developing regulatory program. Subsequent studies of the efficacy of an integrated raw water transmission system approach between TRWD and DWU will address this developing regulatory program.

Section 8
Dallas Water Utilities Additional Treatment and Water Transmission Facilities

8.1 Introduction

The purpose of this portion of the study was to consider additional cost and treatment implications for transmission of raw water to DWU treatment and distribution system facilities from project conveyance Alternatives 1 and 3, which respectively represent the independent and interconnected raw water transmission system (see **Table 1-1** for a full description of these alternatives). These additional treatment and water transmission facilities that may be required for a fully functional integrated strategy for DWU were beyond the initial study boundary (see **Figure 1-3**); therefore, costs implications in this section are additive to the DWU project conveyance alternative costs. These costs do not include distribution system improvements needed downstream of the water treatment plants. This study of three additional treatment and transmission scenarios (see **Table 8-1**) was guided by the following objectives:

1. Document the criteria that will be used in subsequent phases to select the preferred treatment/transmission scenarios and develop a listing of the applicable constraints to these scenarios (e.g. water quality, cost, and permitting complexity).

2. Develop transmission alternatives and treatment modification costs for **Scenario 1: water delivered to or around Joe Pool Lake and conveyed to the existing Bachman Water Treatment Plant (WTP).** Planning-level treatment modifications at the existing Bachman WTP to treat the water from an integrated raw water system were also considered.

3. Develop treatment costs for **Scenario 2**: **water delivered to, and treated at, the proposed Southeast WTP (SE WTP).** In this scenario, raw water would not be conveyed to or stored in Joe Pool Lake and would instead be delivered directly to the SE WTP from the integrated raw watery transmission system. Transmission costs were not included in this scenario because they were included in Interconnection Alternative 3. Treatment costs were based on construction of the new WTP.

4. Develop treatment costs for **Scenario 3**: **a new WTP located near Joe Pool Lake.** Transmission costs were not included in this scenario because they were included in Interconnection Alternatives 3 and 4. Treatment costs were based upon construction of a new WTP near Joe Pool Lake.

Table 8-1
DWU Additional Treatment and Transmission Facilities Scenarios

DWU Scenario	Conveyance	Treatment	Project Conveyance Alternative[1]
1 Bachman WTP	Delivery to or around Joe Pool Lake and conveyance to Bachman WTP	Possible Bachman WTP Process Modifications; Elm Fork Expansion	3 (Interconnected)
2 Southeast WTP	Conveyance included in Raw Water System Integration costs	New Southeast WTP	1 (Baseline)
3 WTP at Joe Pool	Conveyance included in Raw Water System Integration costs	New Joe Pool Lake WTP	3 (Interconnected)

8.2 Evaluation Criteria

In this section, evaluation criteria relate to the selection of a preferred route for transmission of water to the Bachman WTP and the estimation of costs (both capital and life-cycle) for transmission, new water treatment plants, and modifications or expansions to existing plants. This section describes criteria specific to this analysis and any differences between these criteria and those employed in other analyses in this report.

8.2.1 Transmission Infrastructure

A preliminary facility siting constraints analysis is described in Section 4 of this report to identify potential fatal flaws to locating water transmission facilities along select pipeline corridors and to make a comparison between project conveyance alternatives. Though this same level of data collection and analysis was not applied to the transmission routes to Bachman WTP, the criteria used in subsequent phases for the selection of preferred transmission scenarios, and a listing of the applicable constraints to these scenarios.

Transmission routes for this analysis were developed using limited data collection, including aerial photography, institutional knowledge, topography, and data collected for other tasks in this study. Based on this information, a preferred route was selected for cost evaluation. The basis for the capital and life-cycle cost evaluation is the same as described in Section 3 of this report (as applied to the four project conveyance alternatives for the raw water transmission system). The discount rates and cost of debt used in this life-cycle cost analysis correlate (as shown in **Table 8-1**) with the Project Conveyance Alternative discount rates and costs of debt. For example, the DWU baseline alternative rate of 4.58% was used in Scenario 2 and a

[1] Costs for Scenarios 1 through 3 are additive to the Project Conveyance Alternatives. Cost implications to Project Conveyance Alternatives 2 and 4 are not considered separately here because they fall within the bounds of these results.

discount rate of 4.77% was used for Scenarios 1 and 3 to correlate with Project Conveyance Alternative 3.

8.2.2 Water Treatment

Water treatment plant (WTP) construction and operating costs for the three DWU additional treatment and transmission facilities scenarios were based on the following:

- Raw water quality data (developed in Sections 5 and 6);
- Treatment process scenarios developed for the projected raw water quality;
- Recent construction costs for plants with similar processes on a cost per gallon basis;
- Water treatment costs (chemicals and power) associated with treatment only from similar plants treating similar waters;
- Plant capacity of 102 mgd; and
- Operating costs on a cost per gallon basis.

The treatment process selected for comparing the three DWU additional treatment and transmission facilities scenarios is similar to the Bachman WTP process and other current treatment plants served by TRWD. The treatment process includes the following processes:

- Raw water ozonation for primary disinfection, taste and odor control, and iron and manganese oxidation;
- Conventional treatment processes of rapid mix, flocculation, and sedimentation, using ferric sulfate coagulant with coagulant aid polymer;
- Biological filtration for turbidity reduction and assimilable organic carbon (AOC) removal for biological stability;
- Chloramines for residual disinfection;
- Clearwell storage;
- Lime or caustic for pH adjustment;
- Fluosilicic acid for fluoride addition; and
- Sludge lagoons for sludge handling

.

8.3 Scenario 1 – Bachman WTP

In this analysis, Scenario 1 correlates to the cost and water quality analysis found in Project Conveyance Alternative 3 (Interconnected Third Pipeline). Costs from this scenario are additive to Alternative 3 costs and the raw water used in this scenario is the same as that in Alternative 3, a blend of Lake Palestine and Cedar Creek Reservoir water.

8.3.1 Conveyance Alternative Routes in Scenario 1

Using limited data collection, including aerial photography, institutional knowledge, topography, and data collected for other tasks in this study, five feasible transmission routes were developed to deliver water from the integrated raw water transmission system pipelines to the Bachman WTP. These alternatives (all within Scenario 1) included, closed conduit and open channel pathways, delivery to and delivery around Joe Pool Lake, and conveyance through or around Mountain Creek Reservoir. The assumed take-point from the integrated raw water transmission system was from the approximate confluence of Joe Pool Lake and the Third Pipeline (or existing two pipelines) that delivers water from Cedar Creek and Richland-Chambers Reservoirs to Lake Benbrook.

Ground elevation profiles were developed for the five alternative routes to Bachman WTP using USGS contour information. **Figure 8-1** compares centerline ground elevations of each alternative route in Scenario 1. Each alternative route terminates at the same location (Bachman WTP) but differs in the intake location:

- Alternative route A intake is at the downstream end of Joe Pool Lake;
- Alternative route B intake is at a location downstream of Mountain Creek Lake (upstream of this point it is open channel flow);
- Alternative route C flows through Joe Pool Lake and then by gravity to the Trinity River where, after mixing with Trinity River flow, it is pumped to Bachman WTP;
- The intake location of alternative route D is from the Third Pipeline (or existing pipelines from Richland-Chambers and Cedar Creek Reservoirs) on the southwest side of Joe Pool Lake; and
- The intake location for alternative route E is from the Third Pipeline (or existing pipelines from Richland-Chambers and Cedar Creek Reservoirs) on the southeast side of Joe Pool Lake.

Alternative route D traverses the longest distance from the TRWD pipelines interconnection to the Bachman WTP. In **Figure 8-1,** station 0+00 represents the intake location of this longest alternative route and station 1600+00 represents the end location at the Bachman WTP intake. The pipeline profile was taken into consideration for the comparative analysis of the five alternative routes.

Table 8-2 provides some of the considerations used to develop the five alternative routes in Scenario 1. A schematic alignment of each alternative is provided in **Figure 8-2** through **Figure 8-6**. A more complete explanation of some of the "Advantages" and "Disadvantages" listed in **Table 8-2** is given here:

- The conservation pool of Joe Pool Lake is controlled by the U.S. Army Corps of Engineers in conjunction with the Trinity River Authority (TRA), which has contracted to several local customers. At this time, no storage is available to DWU for Lake Palestine water. Conveying water through Joe Pool Lake therefore has associated permitting, storage and operational issues that will require resolution should this alternative be selected.

- The general assumption in **Table 8-2** is that mixing Lake Palestine water with the Trinity River would degrade the Lake Palestine water quality.

- Alternative E – "TRWD Pipelines to Bachman WTP - SH 360 Alternative" assumes that the SH 360 corridor has available right-of-way to accommodate a pipeline. In March 2008, the North Texas Tollway Authority met with representatives from Texas Department of Transportation's Dallas and Fort Worth districts and the North Central Texas Council of Governments (NCTCOG) to discuss agency partnering and corridor planning for SH 360. The parties agreed to meet regularly to discuss scope and agency responsibilities. A description from www.nctog.org/trans/corridor/studies.asp reads: "The recommended improvements to the SH 360 South Corridor extend from Sublett Road/Camp Wisdom Road to the proposed Dallas-Fort Worth Regional Outer Loop south of US 287, passing through the cities of Arlington, Grand Prairie, and Mansfield. From Sublett Road/Camp Wisdom Road to Debbie Lane, SH 360 is planned to include 8 general purpose toll lanes; between Debbie Lane and the Dallas-Fort Worth Regional Outer Loop, 6 general purpose toll lanes are planned. In addition, the entire corridor will include 4 continuous frontage road lanes. The improvements from Sublett Road/Camp Wisdom Road to US 287 are expected to be completed by 2015, and the improvements from US 287 to the Dallas-Fort Worth Regional Outer Loop are expected to be completed by 2025."

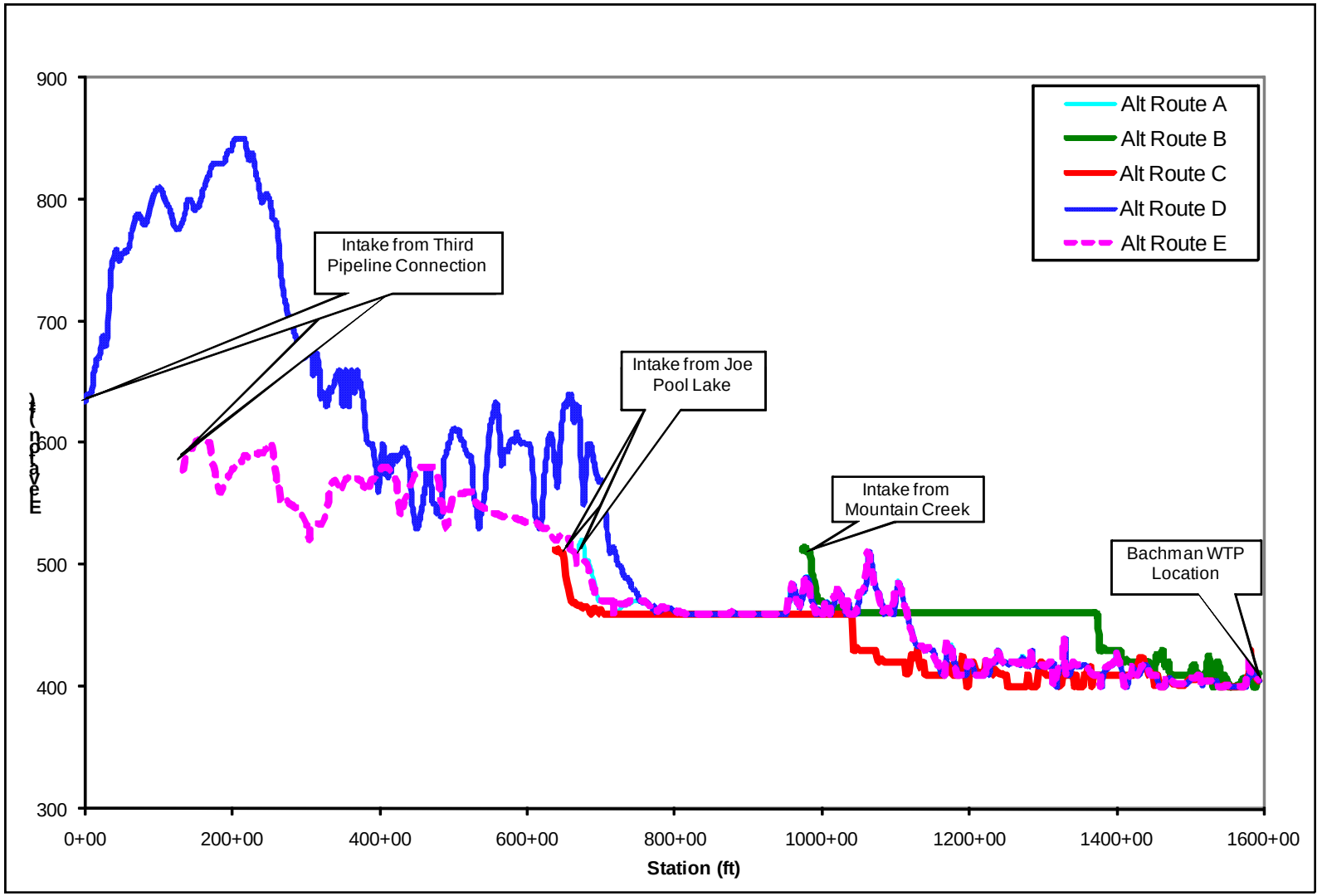


Figure 8-1
Profiles of Scenario 1 Alternative Conveyance Routes to Bachman WTP

Table 8-2
Scenario 1 Alternatives Conveyance Routes

Alternative Route	Description	Type	Pumped Flow Length (ft)	Channel Flow Length (ft)	Advantages	Disadvantages
A	Joe Pool Lake to Bachman WTP	Pumped flow	92,770 (17.6 mi)	0	Avoid potential water quality issues in the Trinity River	High pipeline and operational costs
						Joe Pool Lake permitting/storage issues
						Requires an intake facility at Joe Pool Lake
B	Joe Pool Lake to Bachman WTP	Open channel / Pumped flow	30,192 (5.7 mi)	62,294 (11.8 mi)	Potential cost benefit from reduced pipeline length	Joe Pool Lake permitting/storage issues
						Requires an intake facility on Mountain Creek
C	Joe Pool Lake to Bachman WTP	Open channel /Pumped flow	20,693 (3.9 mi)	75,192 (14.2 mi)	Potential cost benefit from reduced pipeline length	Potential water quality degradation due to Trinity River
						Joe Pool Lake permitting/storage issues
						Requires an intake facility on the Trinity River
D	Third Pipeline to Bachman WTP - Cedar Hill Alternative	Pumped flow	160,075 (30.3 mi)	0	Avoid potential water quality issues in the Trinity River	Highest pipeline and operational costs
					Avoid Joe Pool Lake permitting/storage issues	Permitting issues - pipeline corridor passes through federal & protected park lands
					Eliminate need for additional intake facility	Difficulty of obtaining easements because of urban setting
E	Third Pipeline to Bachman WTP - SH 360 Alternative	Pumped flow	146,669 (27.8 mi)	0	Avoid potential water quality issues in the Trinity River	Higher pipeline and operational costs
					Avoid Joe Pool Lake permitting/storage issues	
					Eliminate need for additional intake facility	
					Eliminate permitting issues associated with Alternative D	

Scenario 1: Transmission to Bachman WTP
Alternative Route A

Bachman Lake

Bachman WTP

Estelle Creek

Bear Creek

Delaware Creek

Elm Fork Trinity River

Trinity River

Vilbig Lakes

West Fork Trinity River

West Dallas Housing Project Lake

Bluebonnet Lakes

Texaco Lake

Coombs Creek

Cottonwood Creek

Mountain Creek Lake

Crow Creek

Kirby Creek

Artesian Creek

Mountain Creek

O'Guinn Creek

Fivemile Creek

Fish Creek

JOE POOL LAKE

Tenmile Creek

Mauk Branch

Legend

- Streets
- Rivers and Streams
- Alternative Route A

N W E S

TARRANT REGIONAL WATER DISTRICT

dallas water utilities
city of dallas

CDM/KBR

0 2,500 5,000 Feet

Figure 8-2

Scenario 1: Transmission to Bachman WTP
Alternative Route B

Bachman Lake
Bachman WTP
Estelle Creek
Elm Fork Trinity River
Delaware Creek
Trinity River
Vilbig Lakes
West Fork Trinity River
Bear Creek
Johnson Creek
Bluebonnet Lakes
Texaco Lake
Coombs Creek
Cottonwood Creek
Mountain Creek Lake
Kirby Creek
Artesian Creek
O'Guinn Creek
Fivemile Creek
Crow Creek
Mountain Creek
Fish Creek
JOE POOL LAKE

Legend

- Streets
- Rivers and Streams

Alternative Route B

- Open Channel Flow
- Pumped Flow

N W E S

Tarrant Regional Water District
dallas water utilities
city of dallas

CDM/KBR

0 2,500 5,000 Feet

Figure 8-3

Scenario 1: Transmission to Bachman WTP
Alternative Route C

Las Colinas Reservoir Number 7
Estelle Creek
Joes Creek
Bachman Lake
Bachman WTP
Elm Fork Trinity River
Delaware Creek
Trinity River
Vilbig Lakes
West Fork Trinity River
Bear Creek
West Dallas Housing Project Lake
Bluebonnet Lakes
Texaco Lake
Cottonwood Creek
Coombs Creek
Mountain Creek Lake
Kirby Creek
Artesian Creek
Mountain Creek
O'Guinn Creek
Fivemile Creek
Crow Creek
Fish Creek
Mauk Branch
JOE POOL LAKE
Tenmile Creek

Legend

- Streets
- Rivers and Streams

Alternative Route C

- Open Channel Flow
- Pumped Flow

N
W
E
S

Tarrant Regional Water District
dallas water utilities
city of dallas
CDM/KBR

0 2,500 5,000 Feet

Figure 8-4

Scenario 1: Transmission to Bachman WTP
Alternative Route D

Lake Carolyn
Las Colinas Reservoir Number 7
Joes Creek
Bachman Lake
Bachman WTP
Elm Fork Trinity River
Delaware Creek
Trinity River
Vilbig Lakes
West Dallas Housing Project Lake
West Fork Trinity River
Bluebonnet Lakes
Texaco Lake
Coombs Creek
Cottonwood Creek
Mountain Creek Lake
Johnson Creek
Kirby Creek
O'Guinn Creek
Crow Creek
Artesian Creek
Fivemile Creek
Fish Creek
Mountain Creek
Mauk Branch
Woody Branch
Lynn Creek
JOE POOL LAKE
John Penn Branch
Bowman Branch
Stewart Branch
Tenmile Creek
Baggett Branch
Bentle Branch
Bee Branch
Heath Creek
Walnut Creek
Magic Valley Ranch Lake
Little Creek
Bear Creek
Low Branch
Red Oak Creek
Hollings Branch
Bedford Branch
North Prong Creek
Gifford-Hill Lake
Soil Conservation Service Site 11 Reservoir
Reece Branch
Soap Creek
Soil Conservation Service Site 1 Reservoir
Soil Conservation Service Site 10 Reservoir

0 4,000 8,000 Feet

Legend

- Streets
- Rivers and Streams
- Alternative Route D
- TRWD RC/CC Pipelines

Figure 8-5

CDM/KBR

Scenario 1: Transmission to Bachman WTP
Alternative Route E

Lake Carolyn
Lake Carolyn
Joes Creek
Bachman Lake
Bachman WTP
Elm Fork Trinity River
Delaware Creek
Trinity River
Vilbig Lakes
West Dallas Housing Project Lake
Bluebonnet Lakes
West Fork Trinity River
Texaco Lake
Johnson Creek
Coombs Creek
Cottonwood Creek
Mountain Creek Lake
O'Gunn Creek
Fivemile Creek
Kirby Creek
Crow Creek
Artesian Creek
Fish Creek
Mountain Creek
Mauk Branch
Woody Branch
Lynn Creek
Bowman Branch
JOE POOL LAKE
John Penn Branch
Stewart Branch
Tenmile Creek
Baggett Branch
Bentle Branch
Bee Branch
Heath Creek
Walnut Creek
Magic Valley Ranch Lake
Little Creek
Low Branch
Hollings Branch
Bedford Branch
North Prong Creek
Soap Creek
Gifford-Hill Lake
Soil Conservation Service Site 11 Reservoir
Soil Conservation Service Site 1 Reservoir

0 4,000 8,000 Feet

Legend

- Streets
- Rivers and Streams
- Alternative Route E
- TRWD RC/CC Pipelines

Tarrant Regional Water District
dallas water utilities
city of dallas
CDM/KBR

Figure 8-6

8.3.2 Conveyance Cost Analysis

The alternative route in Scenario 1 with the combination of highest probable cost and lowest probably disadvantage was selected for the conveyance cost analysis. This selection does not indicate a preference for this route but does provide the decision-maker with a result that bounds the possible cost implications. Alternative route E was selected over the other highest probable cost alternative (route D) because it does not pass through federal and protected park lands on the east of Joe Pool Lake and because it enables gravity transmission to Bachman WTP, as opposed to the higher ground elevations of Alternative D that would lead to more complicated transmission hydraulics.

Alternative route E begins at the southwest corner of Joe Pool Lake at an approximate ground elevation of 600 feet. Using a ground storage tank (GST) to serve as a balancing reservoir for the pipeline, which drops approximately 190-feet from the location of the GST to the headworks of Bachman WTP, a 78-inch pipeline enables gravity flow for the entire length of the route at a design flow of 128 MGD without the need of a booster pump station. Because alternative route E does not utilize a pump station, energy costs do not factor into the life-cycle cost analysis.

Based on the capital and life-cycle cost assumptions described in Sections 1 and 3, the opinion of capital cost for alternative route E in Scenario 1 is $171,132,000 and the Present Value of the 50-year life-cycle cost is $258,729,000.

8.3.3 Bachman WTP

In addition to the conveyance system to Bachman WTP, Scenario 1 includes treatment of raw water from Lake Palestine that has blended with Cedar Creek Reservoir water. The raw water quality for this scenario is as follows:

- Alkalinity 60 mg/L
- Hardness 5 0 mg/L
- TOC 7.0 mg/L
- TDS 132 mg/L
- Bromide 0.09 – 0.12 mg/L
- Iron 81 ug/L
- Manganese 97 ug/L

The treatment process at Bachman WTP, with projected modifications to include biological filtration, would sufficiently treat this raw water supply to meet desired water quality goals. However, due to elevated levels of TOC and manganese, additional ferric sulfate would be required to meet TOC reduction targets and

additional ozone would be required for manganese oxidation and potentially increased demand from higher organic content in the water.

Currently planned improvements to the Bachman WTP include modifications for enhanced coagulation. These improvements include additional chemical storage and feed facilities that would be sufficient for treating the higher levels of TOC associated with Scenario 1.

To facilitate oxidation of the increased levels of manganese in the Lake Palestine/Cedar Creek Reservoir blend, approximately 200 lb/day of ozone would be required. This is a small percentage of the current overall ozone capacity at the plant and existing ozone generators would likely have sufficient capacity to meet this additional requirement. Ozone generation capacity could also be increased by decreasing the ozone in oxygen concentration during periods of high flow and high ozone demand.

Because no additional facilities would be required at the Bachman WTP, the estimated capital cost is zero. The probable operating cost for Scenario 1 (chemicals and power for ozone production) is $60 per MGal treated. This evaluation assumes that the existing Bachman WTP can meet the 102 mgd capacity requirement for Lake Palestine water. However, it does not include the costs for expanding the City's overall treatment plant capacity by 102 mgd. This would likely be done by expanding the Elm Fork WTP by 102 mgd. The cost for expanding such an existing facility, if room for expansion is available, would be comparable to a new plant of the same size, approximately $200,000,000.

8.4 Scenario 2 – Southeast WTP

In this analysis, Scenario 2 correlates to the cost and water quality analysis found in Project Conveyance Alternative 1 (independent system with DWU connection to the SEWTP). Costs from this scenario are additive to Alternative 1 costs and the raw water used in this scenario (Lake Palestine only) is the same as that in Alternative 1. Scenario 2 includes treatment of raw water from Lake Palestine at the new Southeast WTP. The raw water quality for this scenario is as follows:

- Alkalinity 38 mg/L
- Hardness 48 mg/L
- TOC 8.5 mg/L
- TDS 138 mg/L
- Bromide 0.12 mg/L
- Iron 110 ug/L
- Manganese 250 ug/L

The selected treatment process (see Section 8.2.2) would sufficiently treat this raw water supply to meet target water quality goals. However, due to low alkalinity and elevated levels of TOC and manganese, the water will be more difficult to treat than the raw water from Scenario 1, and will require greater quantities of treatment chemicals. Additional ferric sulfate would be required to meet TOC reduction targets and additional ozone would be required for manganese oxidation and potentially increased demand from higher organic content in the water.

The probable construction cost for a conventional water treatment plant with ozonation facilities and onsite sludge lagoons is approximately $2.00 per gallon. This cost is based on recent (2008) construction cost bids for similar facilities. The construction cost of a new 102 mgd water treatment plant would be approximately $204 million. To account for additional ozonation facilities and chemical storage and feed facilities, this cost was increased by 5%. Therefore, the probable capital cost for the new 102 mgd Southeast WTP would be approximately $215,000,000. The probable operating cost (chemicals and power for ozone production) is $66 per MGal treated.

8.5 Scenario 3 – WTP at Joe Pool Lake

In this analysis, Scenario 3 correlates to the cost and water quality analysis found in Project Conveyance Alternative 3 (Interconnected Third Pipeline). Costs from this scenario are additive to Alternative 3 costs and the raw water used in this scenario is the same as that in Alternative 3, a blend of Lake Palestine and Cedar Creek Reservoir water. Scenario 3 includes treatment of raw water from Lake Palestine that has blended with Cedar Creek Reservoir water. It was assumed that raw water would be pulled off prior to discharge into Joe Pool Lake and treated at a new water treatment plant near Joe Pool Lake. The raw water quality for this scenario is as follows:

- Alkalinity 60 mg/L
- Hardness 50 mg/L
- TOC 7.0 mg/L
- TDS 132 mg/L
- Bromide 0.09 – 0.12 mg/L
- Iron 81 ug/L
- Manganese 97 ug/L

The selected treatment process (see Section 8.2.2) would sufficiently treat this raw water supply to meet target water quality goals. The raw water quality is the same as Scenario 1 and would require the same treatment process and treatment requirements. Therefore, the probable construction cost of a new 102 mgd water treatment plant near Joe Pool Lake would be approximately $204 million, not

including the potential cost of purchasing a treatment plant site. The probable operating costs (chemicals and power for ozone production) are $60 per MGal treated.

8.6 Mountain Creek Lake Considerations

8.6.1 Mountain Creek Lake Overview

Mountain Creek Lake was built as a cooling reservoir for a power plant originally constructed in 1938. The reservoir is still used for cooling purposes at the Mountain Creek Generating Station. This power plant is operated by Exelon Corporation according to the Exelon web site[2]. The annual use reports reviewed indicate that this plant may divert between about 120 cfs and in excess of 900 cfs for cooling and other industrial purposes. The TCEQ tabulation of water rights and documents available of record from the TCEQ do not indicate any other CA or permit holder for water from Mountain Lake. TCEQ staff confirmed that it is unlikely another CA or permit holder exists, but that there can be infrequent omissions in the TCEQ database.

Technical Data on Mountain Creek Lake

Water Right – Certificate of Adjudication 08-3408

Water Right Owner – ExTex LaPorte

Reservoir Owner – ExTex LaPorte

Stream – Mountain Creek, tributary of the Trinity River

County – Dallas County

Conservation Storage Capacity – 22,840 acre-feet

Maximum Diversion – "Owner is authorized to divert and consumptively use not to exceed 6400 acre-feet of water per annum from the aforesaid reservoir for industrial purposes."

Maximum Diversion Rate – The maximum combined rate of diversion specified in Certificate of Adjudication 08-3408, Paragraph 3.B. has been marked out in the copy received from TCEQ. No maximum diversion rate is specified in the tabulation of water rights maintained by TCEQ.

Priority Date: March 12, 1929

Environmental Flow Requirements – none indicated in materials reviewed

As with the other reservoirs we have studied on the Trinity River, the water right for Mountain Creek Reservoir does not expressly authorize surface water to be stored in the reservoir from sources outside the Trinity River basin, nor does the water right preclude such storage. The CA also did not include special provisions,

[2] ExTex LaPorte and Exelon appear to be related entities.

such as environmental flow requirements or conservation requirements for wholesale water users that would otherwise affect storage or transmission of water from outside the Trinity River basin in or through Mountain Creek Reservoir.

We note that the Mountain Creek Generating Station pumps a large amount of water from Mountain Creek Reservoir for cooling and other industrial purposes. This may cause the reservoir level to fluctuate, affect the temperature of the water in the reservoir, and otherwise affect water passing through the reservoir. The CA for the reservoir is senior to that of the Lake Palestine transfer (and most other water rights in the area), and so the transfer must be implemented so as to not affect these senior rights. The CA allows the holder to divert and consumptively use only 6,400 acre-feet of water annually. According to the annual use reports, the generating station diverted 491,230.81 acre-feet from Mountain Creek Lake in 2004, and consumed 1084.456 acre-feet. These figures are consistent with or lower than past years. Our interpretation of the diversion restriction imposed by the CA is that the power plant is currently exceeding its allowable diversions, but that these large diversions may not detrimentally affect the amount of water available to other water right holders. Any subsequent use of the reservoir by Dallas Water Utilities would need to take into account the generating station's permitted diversions rather than its current actual diversions.

See **Figure 8-7**, prepared by the City of Dallas, depicting the general location of Mountain Creek Lake and its watershed.

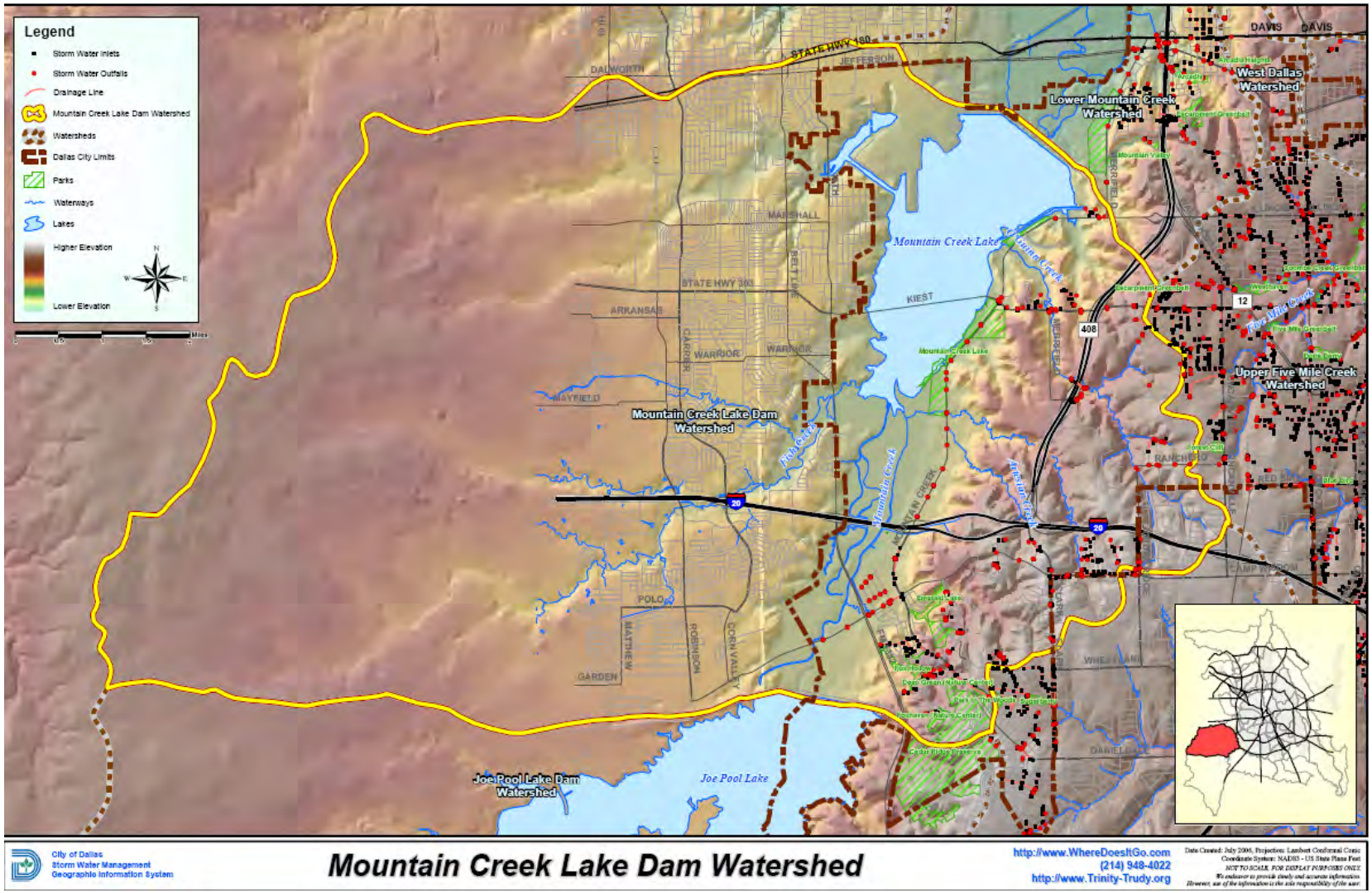


Figure 8-7
Mountain Creek Lake Dam Watershed

8.6.2 Mountain Creek Water Quality

Under one of the alternative routes in Scenario 1 discussed above, 102 mgd of the interconnected TRWD/DWU water would be routed from Joe Pool Lake through Mountain Creek Lake to the Bachman WTP. The Texas Commission on Environmental Quality (TCEQ) has identified water quality concerns in Mountain Creek Lake. The following provides a summary of the water quality concerns associated with this water body and evaluates their importance with regards to the water routing proposal.

Existing Water Quality

The following sections summarize what is known regarding existing water quality in Joe Pool and Mountain Creek Lakes.

Joe Pool Lake – Joe Pool Lake is a 7,470 acre reservoir that is protected for the following beneficial uses: Aquatic life, contact recreation, general, fish consumption and public water supply. Reservoir water quality is regularly assessed by TCEQ every two years; the latest draft assessment was completed in March 2008 (TCEQ 2008). This assessment reported that water quality in the reservoir is good with all assessed beneficial uses fully supported – including the public water supply use. The 2008 findings are consistent with assessments completed in previous years.

Mountain Creek Lake – This lake is a 2,710 acre reservoir that is protected for the following beneficial uses: Aquatic life, contact recreation, general, fish consumption and public water supply. In contrast to Joe Pool Lake, this reservoir has water quality concerns – but only as applicable to the protection of the fish consumption use (TCEQ 2008). No concerns have been identified for other beneficial uses, e.g., public water supply (TCEQ 2008).

The fish consumption advisory was issued on April 25, 1996 as result of lake studies conducted in 1994-1995 by the U.S. Geological Survey (see Van Metre et al. 2003). These studies showed elevated concentrations of PCBs, chlordane, heptachlor epoxide, and DDT (and its byproducts DDD and DDE), in sediments and fish tissue that exceeded Texas Department of Health (TDH) guidelines for the consumption of fish. Sources of these contaminants date back to activities occurring along and near the lake at the Naval Air Station Dallas and the Naval Weapons Industrial Reserve Plant, primarily from 1941 to 1974.

Changes in discharge practices and implementation of state and federal environmental laws and regulations since the 1970s have resulted in a gradual improvement in sediment quality. For example, Van Metre et al. (2003) showed substantial differences in sediment quality with sediment depth in the lake bottom. Older, deeper sediments had substantially higher levels of contaminants than newer, surficial sediments. This change demonstrates that contaminant control and

remediation activities are resulting in a greatly reduced load of contaminants to the reservoir.

Van Metre et al. (2003) identified a number of concerns regarding contaminants in fish tissue including PCBs and various organochlorine pesticides. For metals, only selenium was identified as a concern, but no concerns were identified for other organic chemicals such as polycyclic aromatic hydrocarbons (PAHs) and volatile organic compounds (VOCs).

Ultimately, the outcome from the findings of this study was the listing of Mountain Creek Lake as an impaired waterbody requiring a Total Maximum Daily Load (TMDL) to address impairment of the fish consumption use. This listing was based solely on the fish tissue data and resulting fish consumption advisory for the following contaminants: DDT, DDD, DDE, chlordane, dieldrin, PCBs and heptachlor epoxide. The listing was not based on the finding of any contaminants at levels of concern in the water column.

In June 2001, the Environmental Protection Agency approved a TCEQ adopted TMDL established, in part, to address the fish consumption impairment in Mountain Creek Lake (TCEQ, 2000). Subsequently, the TCEQ adopted a plan to implement the EPA-approved TMDL (TCEQ, 2001). This plan relies on the continued remediation of contaminant sources at source sites (e.g., Naval Air Station) to prevent any additional loadings to the lake, e.g., through the runoff of stormwater, and the passage of time to achieve compliance. As correctly noted in the TMDL, source control is critical so that no new loadings to the waterbody occur, but a key means for achieving success is to allow time for natural attenuation processes to occur.

Natural attenuation relies on the natural process of sedimentation to the lake to deposit clean sediment over contaminated sediment. Clean bottom sediments prevent contaminants from being consumed by invertebrates which are in turn consumed by fish resulting in bioaccumulation in fish tissue. Over time (many years) the result of natural attenuation will be a gradual reduction in fish tissue concentrations. The time to success will be improved the more quickly the sources of contaminants in the watershed are eliminated.

Efforts to reduce contaminant loadings have been ongoing for some time. TDH (2002) provides evidence that this process is gradually improving water quality. They note that in 1995 67 of 68 fish tissues samples contained the PCB congener Aroclor 1260. Of 10 samples collected in 2000 and 2001 Aroclor 1260 was detected in only one fish sample. Although this result suggests that water quality management efforts are resulting in water quality improvements, TDH wanted to collect more data before determining whether PCB levels were low enough to support removal of the fish consumption advisory (at least for PCBs). As of this date, the fish consumption advisory remains in place.

Water Quality Discussion and Recommendations

Based on the review of Joe Pool Lake and Mountain Creek Lake water quality data, it is unlikely that routing water through Mountain Creek Lake to Bachman WTP will result in any drinking water quality concerns. This finding is based on the following:

- Water quality in the source water (Joe Pool Lake plus Lake Palestine, or Lake Palestine/Cedar Creek Reservoir blends) is good and the blended interconnected supplies would be acceptable for drinking water uses as previously discussed in Section 5;

- TCEQ has repeatedly made a regulatory finding that water quality in Mountain Creek Lake fully supports the Public Water Supply beneficial use.

- Water quality concerns in Mountain Creek Lake are limited to sediment and fish tissue – not the water itself. These concerns are also primarily associated with the Cottonwood Bay portion of the reservoir and not the main lake.

- A TMDL has been established which is aggressively addressing contaminant loadings to the reservoir.

- Evidence exists (TDH 2002) that contamination mitigation efforts are resulting in less contamination in fish tissue.

While these findings suggest that routing water through the reservoir is a viable option with regards to water quality, the following recommendations should be considered if that option is pursued:

- Because a TMDL exists on the reservoir, this option should be discussed with TCEQ to identify any concerns that they may have. Discharging water from Joe Pool Lake to Mountain Creek Reservoir changes the dynamics of the reservoir and may need to be factored into TCEQ's TMDL implementation program.

- The TCEQ periodically assesses water quality in Mountain Creek Lake as part of the state biannual waterbody assessment process. If this reservoir becomes a source location for the Bachman WTP, the treatment facility may want to conduct additional source water sampling to supplement TCEQ's monitoring program.

8.7 Summary and Conclusions

Table 8-3
DWU Additional Treatment and Water Transmission Facilities
Summary Conclusions

Results	DWU Scenario		
	1 Bachman WTP	**2 Southeast WTP**	**3 WTP at Joe Pool**
Conveyance Capital Cost[(1)]	$171,132,000	n/a	n/a
Treatment Infrastructure Capital Cost	No Cost at Bachman WTP + Elm Fork Expansion (~$200,000,000)	$215,000,000	$204,000,000
Treatment Op. Cost (per MGal Treated)	$60	$66	$60
Present Value of 50-year Life-Cycle Cost	$782,604,000[(2)]	$572,321,000	$554,872,000
Notes	Costs for expanding DWU's overall treatment plant capacity by 102 mgd (by expanding the Elm Fork WTP if room for expansion is available) would be comparable to a new plant of the same size	Cost for conveyance is included in Project Conveyance Alternative costs	Cost for conveyance is included in Project Conveyance Alternative costs

Note (1): Distribution system costs (downstream of the WTP) are not included.

Note (2): The replacement of 102 mgd capacity at Elm Fork WTP is included in this figure. If this cost is excluded, the Present Value of the 50-year life-cycle cost is $335,572,000.

Modifications to Bachman WTP treatment process:

- Biological filtration (currently being implemented);
- Additional ferric sulfate storage and feed facilities to meet desired TOC reduction (current enhanced coagulation improvements should meet these requirements); and
- Additional ozone generation capacity (approximately 200 lb/day) for manganese oxidation (existing plant ozonation facilities should be capable of providing this increased ozone requirement)

Proposed Southeast WTP

- Due to low alkalinity and elevated levels of TOC and manganese, the water would be more difficult to treat than the raw water from Scenario 1 (at Bachman WTP);
- Additional ferric sulfate addition would be required to meet desired TOC reduction; and

- Additional ozone would be required for manganese oxidation and due to increased demand from higher organic content in the water.

Proposed Joe Pool Lake WTP: raw water quality would be the same as that for Scenario 1 (at Bachman WTP) and would require the same treatment process and treatment requirements.

Mountain Creek Lake

The Mountain Creek Lake water right does not expressly authorize surface water to be stored in the reservoir from sources outside the Trinity River basin, nor does the water right preclude such storage. The Certificate of Adjudication also does not include special provisions, such as environmental flow requirements or conservation requirements for wholesale water users that would otherwise affect storage or transmission of water from outside the Trinity River basin in or through Mountain Creek Lake.

Based on the review of Joe Pool Lake, Lake Palestine, Cedar Creek Reservoir and Mountain Creek Lake water quality data, it is unlikely that routing water through Mountain Creek Lake to Bachman WTP will result in any significant drinking water quality concerns. These findings suggest that the option to route water through Mountain Creek Lake is a viable option with regards to drinking water quality.

Section 9
Preliminary Findings and Recommendations

9.1 Preliminary Findings

The purpose of this initial Project Viability Assessment and Business Case Evaluation was to 1) identify any "fatal flaws" to developing an integrated raw water transmission system; and 2) compare the separate, independently adopted water strategies of both TRWD and DWU with integrated raw water delivery system alternatives in terms of their life-cycle cost implications, water quality and treatment implications, and permitting and environmental issues. Six tasks were completed as part of this initial Project Viability Assessment and Business Case Evaluation.

1. Integrated system operations analysis;
2. Capital and life-cycle cost analysis;
3. Facility siting constraints assessment;
4. Environmental water quality review;
5. Consideration of water treatment impacts; and
6. Permitting and regulatory review.

At the outset of this initial Project Viability Assessment and Business Case Evaluation, the project team recognized that separate, sound water management strategies are already in place for both DWU and TRWD and that any integrated, joint-agency approach would need to meet several key objectives to complement or replace existing plans:

- An integrated raw water transmission system alternative must enhance the redundancy, flexibility, and demand risk management of the existing water supply systems;
- An interconnected plan must make sufficient water supply available to meet demands where and when needed, under a full range of historical hydrological conditions;
- An integrated raw water transmission system alternative must reduce capital and life-cycle costs, while not contributing to unmitigated treatment or distribution costs for DWU or TRWD customers; and

- All scenarios must fully consider societal, environmental, and regulatory complexities

With these key objectives guiding the way, four project conveyance alternatives were developed through a progressive screening approach to evaluate combinations of conveyance infrastructure and interconnections. Two Baseline Alternatives (independent water strategies) and the two most promising Interconnection Alternatives (integrated delivery systems) were then selected (as described in **Table 1-1** and repeated below for the reader's convenience). Key findings from the six tasks as they relate to the objectives listed above are here presented based on the analysis of these four project conveyance alternatives.

Alternative	Description
1 (Baseline)	Independent Systems: TRWD's East Texas Third Pipeline and DWU's connection of Lake Palestine to the proposed Southeast Water Treatment Plant
2 (Baseline)	Independent Systems: TRWD's East Texas Third Pipeline and DWU's connection of Lake Palestine to Joe Pool Lake
3 (Interconnection)	Integrated System: Interconnected Third Pipeline (upsized as compared to the baseline condition) with connection of Lake Palestine to Cedar Creek Reservoir and delivery to DWU at Joe Pool Lake and TRWD's customers through the Third Pipeline
4 (Interconnection)	Integrated System: Interconnected "Southern Pipeline" - Lake Palestine delivered to the Lake Benbrook pipeline via a pipeline route to the south of the TRWD Third Pipeline route. Delivery to DWU at Joe Pool Lake and TRWD's customers through connections to the existing system and the Lake Benbrook pipeline.

9.1.1 Conclusions from Integrated Operations Analysis

The purpose of this analysis was to identify opportunities for benefits, or potential disadvantages, to both TRWD and DWU through integrated operations of the raw water transmission systems from Lake Palestine, Richland-Chambers Reservoir, and Cedar Creek Reservoir. This comparison of Baseline Alternatives 1 and 2 with Interconnection Alternatives 3 and 4 (see Table 1-1) was driven by a system operations model and the team's water resource planning experience. This model was formulated as a decision-support system that permitted the user to create an array of scenarios that help answer a series of primary and secondary questions, formulated jointly by the project participants during workshops:

In this context, we can conclude the following regarding operating costs, water sharing and timing, redundancy, flexibility, and regional cooperation:

9.1.2 Operating Costs

The integrated operations modeling shows that operating costs within the bounded system are lower in interconnected alternatives as compared to baseline alternatives. This opportunity for operational cost savings is more pronounced in the near term and decreases over time as the difference between interconnected and independent

operations is minimized. This near-term savings is attributed to the fact that the full amount of DWU water supply from Lake Palestine is not required immediately. (DWU access to the TRWD supply system could extend the need to connect the Lake Palestine supply to each system.)

9.1.3 Water Sharing and Timing

The integrated operations modeling found that there is opportunity to make extra water available to water user groups via an interconnected system. The analysis suggests that even under drought conditions in 2020, approximately 80 additional mgd could be available. This result is based on three modeling protocols: 1) water availability is limited by existing TRWD permits (for Richland-Chambers, Cedar Creek, and the planned wetlands); 2) DWU demand is equal to the contracted amount in Lake Palestine (102 mgd); and 3) conveyance is limited by the capacity of existing and planned TRWD conveyance facilities.

This result also confirms that Lake Palestine supply will be required prior to 2020 if the DWU demand reaches 102 mgd (though not all of it will be required immediately and dependence upon it as a source could conceivably be phased). Additions to conveyance capacity could be phased through 2030. TRWD requires water supply in addition to sources already included in the model, such as the constructed wetlands, between 2030 and 2040 (based on existing permit constraints and projected demands).

Interconnection also provides the opportunity for TRWD to use the 102 mgd from Lake Palestine. This water sharing may be useful in an emergency situation or in a localized drought condition that causes deficit in the TRWD system while excess is available to DWU. This opportunity to share water between the two water providers is also a method of demand risk management to mitigate the effects of unforeseen demand growth patterns in the TRWD or DWU systems.

By the year 2030, any configuration of the system becomes supply limited, and reliability predictions during severe droughts would be roughly equivalent among configurations. However, during normal hydrologic periods, extra supply is available through 2060 in an interconnected system, though TRWD may have conveyance limitations to accessing the water. The analysis also indicates that the TRWD system can support sustained withdrawals above the current permitted levels. In other words, supply is limited by the permitted amounts, not water availability.

With an interconnected system, any additional water above projected demands would conceivably be available to any water user group, provided that conveyance capacity would be adequate. With separate systems, this water would not be available to DWU and TRWD and its customers would not benefit from potential sales or trades of water above projected TRWD customer demands. With an interconnected system, there is also the possibility of bringing other, currently independent sources (such as DWU reuse water) and new water supply sources (Toledo Bend, Oklahoma, etc.) into the interconnected system to enhance the potential for water sharing.

To satisfy the DWU demands as they are represented in the model, the full yield of Lake Palestine (102 mgd) is needed immediately if the two systems remain separate. If conveyance systems are interconnected, use of Lake Palestine could ramp up gradually (assuming TRWD water supply in excess of projected demands could help satisfy DWU demand). This offers significant benefits with respect to phased infrastructure that are not available with separate systems.

9.1.4 Redundancy

Operational redundancy is a "belt and suspenders" approach to risk management that enables the water supplier to select from multiple supply sources in times of emergency, drought, failure, etc. An interconnected supply system therefore provides more opportunity for supply and failure risk management.

In the event of a pipe failure or power outage, an integrated transmission system has more alternative flow pathways and connections to multiple water and power sources. These additional connections lower risk to the water provider. The impacts of climatic variations are also lessened because of the diversification of reservoir locations. An interconnected system "casts a wider net" to reservoirs in different watersheds that will potentially experience drought in different times or levels of severity. Also, access to additional sources that may not be fully utilized adds supply redundancy to the system.

9.1.5 Operational Flexibility

Under prevailing ("normal") hydrologic conditions when the modeled system is not supply-limited, an interconnected system offers more operational flexibility than separate sources, since multiple flow pathways could be used to transport water. Such flexibility could be used to capitalize on advantageous opportunities for blending of sources, pump cycling schedules, system maintenance and energy management. One potential disadvantage of operations in an integrated system is the potential for increased operational complexity and the attendant new systems and protocols that must be developed to manage such a system.

The interconnected system also provides flexibility in terms of water availability. Extra supply is available through 2060 in an interconnected system and the analysis indicates that the TRWD system can support sustained withdrawals above the current permitted levels. This ability to overdraft supply sources provides flexibility to system operations, the potential for lower operating costs, and risk mitigation.

The National Water Research Institute in its November 2007 white paper entitled "Water 2010: A 'Near Sighted' Program of Water Resource Management Improvements for the Western United States" recommended system interties as its number one action item for state and local policymakers. NWRI concluded that "System interties increase the flexibility of system operators to respond to weather events, natural disasters, contaminations incidents, or the need to take water treatment or conveyance facilities temporarily off-line for repair or

refurbishment……many interconnections can be planned and constructed within just a few years and at a relatively low cost."

9.1.6 Regional Cooperation

TRWD and DWU have a long history of cooperation in water supply planning, including the Texas Water Development Board regional water planning efforts initiated by the 1997 passage of Senate Bill 1 in the 75th session of the Texas Legislature. This on-going cooperation has led to this study and the potential for raw water transmission system interconnection. The interconnection of the two systems provides opportunities for benefit to both agencies by laying the groundwork for interconnecting future water supply sources (Toledo Bend, Oklahoma, etc.), increasing the portfolio of water supply options, reducing the costs of right-of-way through earlier acquisition, providing financing risk management, and compliance with TWDB planning guidelines.

The groundwork for regional cooperation in accessing future water supply options has already been laid; integrated water supply infrastructure provides additional opportunity for cost savings and will facilitate future inter-local agreements. By interconnecting the transmission system, each agency also effectively increases its portfolio of water supply options through the potential to share water and infrastructure.

Escalating costs for right-of-way acquisition (and urbanization) also point to the benefits of securing transmission routes early. This early acquisition presents an opportunity to acquire sufficient right-of-way for future joint water supplies. TRWD has recently experienced the following average costs for securing easements for several large diameter transmission system projects, costs which raise the issue of expedited acquisition of right-of-way for this and other future joint projects:

- Real estate classified as rural - $15,415 per acre.
- Real estate classified as undeveloped, planned - $33,792 per acre.
- Real estate classified as developed - $71,247 per acre.

Escalation in the cost of materials and ever increasing pressure on the financing market also point to the benefits of interconnection. Economies of scale and the ability to leverage the joint financing capacity of both agencies are benefits in integration.

Along with the other opportunities for benefits through integration, this regional cooperation is in compliance with TWDB guidelines for water supply planning. These guidelines and the TWDB planning process require this cooperation.

9.1.7 Summary of Integrated Operations Conclusions

From an operational perspective, the analysis supports further investigation of interconnected conveyance alternatives. Unlike separate systems, an interconnected system that routes Lake Palestine through the planned TRWD system offers reduced operating costs, cost sharing, savings due to infrastructure phasing, opportunities for water sharing, the potential for increased overall system yield and supply reliability, redundancy, and operational flexibility with respect to infrastructure scheduling and daily operations.

These results indicate a broad range of potential benefits that could be realized with an interconnected system as opposed to separate systems. Subsequent sections of this report address other factors relevant to interconnections, such as water quality, treatment requirements, environmental impacts, etc. Subsequent phases of work will establish operating protocols and cost agreements for shared conveyance and shared supply, and will address permitting needs.

9.1.8 Lifecycle Cost Analysis

Results from this screening level cost analysis show that there are opportunities for significant cost savings through integrated conveyance system alternatives to deliver DWU and TRWD supplies. Delivering water through an Interconnected Third Pipeline has potential Present Value, 50-year lifecycle cost savings between approximately $220,000,000 and $540,000,000.

The Interconnected Southern Pipeline alternative has potential Present Value, 50-year life-cycle cost savings when compared to Alternative 2 (baseline with delivery to Joe Pool) but increased cost when compared to Alternative 1 (baseline with delivery to SE WTP). However, because the Interconnected Southern Pipeline delivers water to Joe Pool Lake and not the SE WTP, the most direct comparison is between the Interconnected Southern Pipeline and Alternative 2, which results in an approximate $36,600,000 savings. Subsequent phases of this feasibility assessment will consider other potential benefits from the Southern Pipeline, such as supply risk reduction and right-of-way acquisition for future supplies. Escalating costs raise the issue of expedited acquisition of right-of-way (e.g. in the Southern Pipeline route) to manage the availability and cost of acquisition for this and future water supplies from East Texas. Also, phasing could also result in significant reduction of costs associated with the Interconnected Southern Pipeline due to the potential to defer development of transmission facilities required to deliver water to Lake Benbrook.

9.1.9 Environmental Water Quality and Water Treatment

Integrating Lake Palestine water into the DWU and TRWD raw water supply systems will have a low to moderate impact on environmental water quality and treatment at the receiving reservoirs and at the water treatment plants. The major impacts of the Lake Palestine water on water treatment relate to its low alkalinity, high TOC, and high manganese concentrations. The importation of Lake Palestine water will result in higher nutrient levels at the studied receiving reservoirs but will not likely to lead

to impacts that impair the designated uses of the water bodies. Additional studies will help predict the complex kinetic relationships between nutrients and chlorophyll-a, particularly for those reservoirs where additional water management strategies include supply augmentation with reuse water.

9.1.10 Ellis and Johnson Counties

The Region C Four County Study (by Freese & Nichols, Inc.) concluded that population and demand projections are exceeding those included in the 2006 Region C water plan. Both TRWD and DWU have existing and projected wholesale customers in Ellis and Johnson Counties to be served by the integrated conveyance systems analyzed in this study. Further development of the raw water transmission integration alternatives will allow TRWD and DWU to consider how these demands can be jointly met in terms of supply, infrastructure and contractual agreements, including advancement of the Trinity River Authority Ellis County Water Supply Project recommended in the Region C Water Plan.

9.1.11 DWU Additional Treatment and Transmission Facilities

This task considered additional cost and treatment implications for transmission of raw water to DWU treatment and distribution system facilities from project conveyance Alternatives 1 and 3, which respectively represent the independent and interconnected raw water transmission system. These additional treatment and water transmission facilities that may be required for a fully functional integrated strategy for DWU were beyond the initial study boundary; therefore, costs implications in this section are additive to the project conveyance alternative costs. These costs do not include distribution system improvements needed downstream of the water treatment plants.

Table 9-1
DWU Additional Treatment and Transmission Facilities

Results	DWU Scenario		
	1 Bachman WTP	**2 Southeast WTP**	**3 WTP at Joe Pool**
Conveyance Capital Cost(1)	$171,132,000	n/a	n/a
Treatment Infrastructure Capital Cost	No Cost at Bachman WTP + Elm Fork Expansion (~$200,000,000)	$215,000,000	$204,000,000
Treatment Op. Cost (per MGal Treated)	$60	$66	$60
Present Value of 50-year Life-Cycle Cost	$782,604,000(2)	$572,321,000	$554,872,000
Notes	Costs for expanding DWU's overall treatment plant capacity by 102 mgd (by expanding the Elm Fork WTP if room for expansion is available) would be comparable to a new plant of the same size	Cost for conveyance is included in Project Conveyance Alternative costs	Cost for conveyance is included in Project Conveyance Alternative costs

Note (1): Distribution system costs (downstream of the WTP) are not included.
Note (2): The replacement of 102 mgd capacity at Elm Fork WTP is included in this figure. If this cost is excluded, the Present Value of the 50-year life-cycle cost is $335,572,000.

Modifications to Bachman WTP treatment process

- Biological filtration (currently being implemented);
- Additional ferric sulfate storage and feed facilities to meet desired TOC reduction (current enhanced coagulation improvements should meet these requirements); and
- Additional ozone generation capacity (approximately 200 lb/day) for manganese oxidation (existing plant ozonation facilities should be capable of providing this increased ozone requirement)

Proposed Southeast WTP

- Due to low alkalinity and elevated levels of TOC and manganese, the water would be more difficult to treat than the raw water from Scenario 1 (at Bachman WTP);
- Additional ferric sulfate addition would be required to meet desired TOC reduction; and

- Additional ozone would be required for manganese oxidation and due to increased demand from higher organic content in the water.

Proposed Joe Pool Lake WTP: raw water quality would be the same as that for Scenario 1 (at Bachman WTP) and would require the same treatment process and treatment requirements.

Mountain Creek Lake

The Mountain Creek Lake water right does not expressly authorize surface water to be stored in the reservoir from sources outside the Trinity River basin, nor does the water right preclude such storage. The Certificate of Adjudication also does not include special provisions, such as environmental flow requirements or conservation requirements for wholesale water users that would otherwise affect storage or transmission of water from outside the Trinity River basin in or through Mountain Creek Lake.

Based on the review of Joe Pool Lake, Lake Palestine, Cedar Creek Reservoir and Mountain Creek Lake water quality data, it is unlikely that routing water through Mountain Creek Lake to Bachman WTP will result in any significant drinking water quality concerns. These findings suggest that the option to route water through Mountain Creek Lake is a viable option with regards to drinking water quality.

9.2 Triple Bottom Line Business Case Evaluation

The project findings can be briefly summarized in terms of a comparison of positive or negative impacts of interconnection alternatives vs. baseline plans as shown in **Table 9-2** in a Triple Bottom Line Matrix.

Table 9-2
Triple Bottom Line Matrix
Comparison of Interconnection and Baseline Alternatives

Project Element	Economic	Environmental	Social
Capital Costs	+		
Life-cycle Cost	+		+
Water Treatment Implications	–		
Permitting/Constraints	+	–	
Environmental Water Quality		–	
Water Sharing and Timing, Redundancy, Flexibility	+	+	
Regional Cooperation and Future Water Supply	+	+	+
Ellis County Service			+

9.3 Recommendations

This initial feasibility study was tasked with assessing the "fatal flaws" and "business case" for a joint, integrated regional approach to water supply and raw water transmission. The findings of this study identify the economic, social and environmental potential of such a project, and clearly suggest that the prospect of interconnecting Lake Palestine through the TRWD system offers benefits that warrant further consideration.

Conceptual engineering and operational scenarios were analyzed in this effort; further analysis is needed to more fully develop how such a joint project would be planned, designed and operated to optimize economic and operational benefits to both systems. This subsequent effort must be initiated quickly due to impending supply constraints and is paramount to support development of institutional agreements and a financing strategy that will be required.

9.3.1 Conceptual Design Phase

It is recommended that TRWD and the City of Dallas proceed to a Conceptual Design Phase. The purpose of this second phase is to further develop:

- The conveyance alternatives (with more detailed hydraulic and operational analysis);
- The phasing potential of an integrated plan; and
- The cost analysis based on additional conceptual design details.

This will, in turn, support parallel organizational discussions regarding cost- and gain-sharing and the terms of a long-term institutional framework. At the conclusion of the conceptual design phase, both parties should have sufficient decision support to consider moving forward with detailed design and construction.

TRWD and the City of Dallas may, based upon the recommendations of this study, decide to further pursue joint interconnected raw water conveyance from Cedar Creek Reservoir, Richland–Chambers Reservoir and Lake Palestine. Despite a compressed timeframe for project development, careful additional study of the various issues mentioned above is recommended.

A conceptual design phase is recommended that would be jointly funded under an existing agreement between the City of Dallas and TRWD. Additional definition of infrastructure requirements at a conceptual level and further operational analysis will provide more detailed cost information. This report is a first step toward determining the viability of integrated water supply and transmission. The general OBJECTIVES of this planning and conceptual design process are:

1. Provide additional technical information to support the City of Dallas and TRWD and its primary wholesale customers with understanding project benefits and manage institutional and financial consequences;

2. Continue to advance project planning and development prior to detailed design to accommodate a 2015 delivery date;

3. Mitigate project cost and schedule variance; and

4. Ensure that the principles of the National Environmental Policy Act (NEPA) are considered early in the planning process to expedite all regulatory decisions, permitting and land acquisition.

Five **TASKS** have been identified to meet these objectives and will provide additional technical, operational, water quality, financial and contractual guidance to support decision making and project delivery. This information is needed so that that the City of Dallas, TRWD and its primary wholesale customers can make clear decisions regarding project costs, schedule, operations, and financing in support of a 2015 water delivery date:

1. Conceptual Design and Project Cost Analysis;

2. Environmental and Permitting Assessment (following NEPA principles);

3. Organizational and Financial Assessment;

4. Project Delivery, Schedule and Cost Management Plan; and

5. Delivery to DWU Water Treatment System.

Tarrant Regional Water District/ City of Dallas

SUMMARY REPORT

Project Viability Assessment and Business Case Evaluation of Raw Water Transmission System Integration

July, 2008

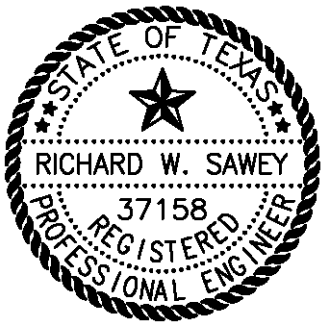
CDM/KBR

In Association with: R.W. Beck, KStrategies, TRC/Brandes, Espey Consultants, Inc., Patrick, Miller & Kropf, P.C., Crespo Consulting Services, Inc.

TARRANT REGIONAL WATER DISTRICT / CITY OF DALLAS

SUMMARY REPORT

PROJECT VIABILITY ASSESSMENT AND BUSINESS CASE EVALUATION OF RAW WATER TRANSMISSION SYSTEM INTEGRATION



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Executive Summary

The Tarrant Regional Water District (TRWD) and the City of Dallas Water Utilities (DWU) have developed a comprehensive list of new water management strategy recommendations that include connecting Lake Palestine to the DWU water system; completion of the TRWD constructed wetlands, and construction of TRWD's Third East Texas Pipeline from Cedar Creek and Richland-Chambers Reservoirs in approximately 2015. The geographic proximity of Lake Palestine to the existing TRWD water supplies and raw water transmission facilities at Cedar Creek and Richland-Chambers Reservoirs (as shown in **Figure ES-1**) and the similarity between the proposed implementation of these water supply strategies prompted DWU and TRWD to begin preliminary discussions about an opportunity to explore an integrated approach to bring additional water into the Dallas and Tarrant Regional Water District service areas.

The purpose of this initial Project Viability Assessment and Business Case Evaluation was to 1) identify any "fatal flaws" to developing an integrated raw water transmission system; and 2) compare the separate, independently adopted water strategies of both TRWD and DWU with integrated raw water delivery system alternatives in terms of their life-cycle cost implications, water quality and treatment implications, and permitting and environmental issues. In other words, this study compared the current water supply plans of each agency with integrated raw water transmission system alternatives.

Six tasks were completed as part of this initial Project Viability Assessment and Business Case Evaluation.

1. Integrated system operations analysis;
2. Capital and life-cycle cost analysis;
3. Facility siting constraints assessment;
4. Environmental water quality review;
5. Consideration of water treatment impacts; and
6. Permitting and regulatory review.

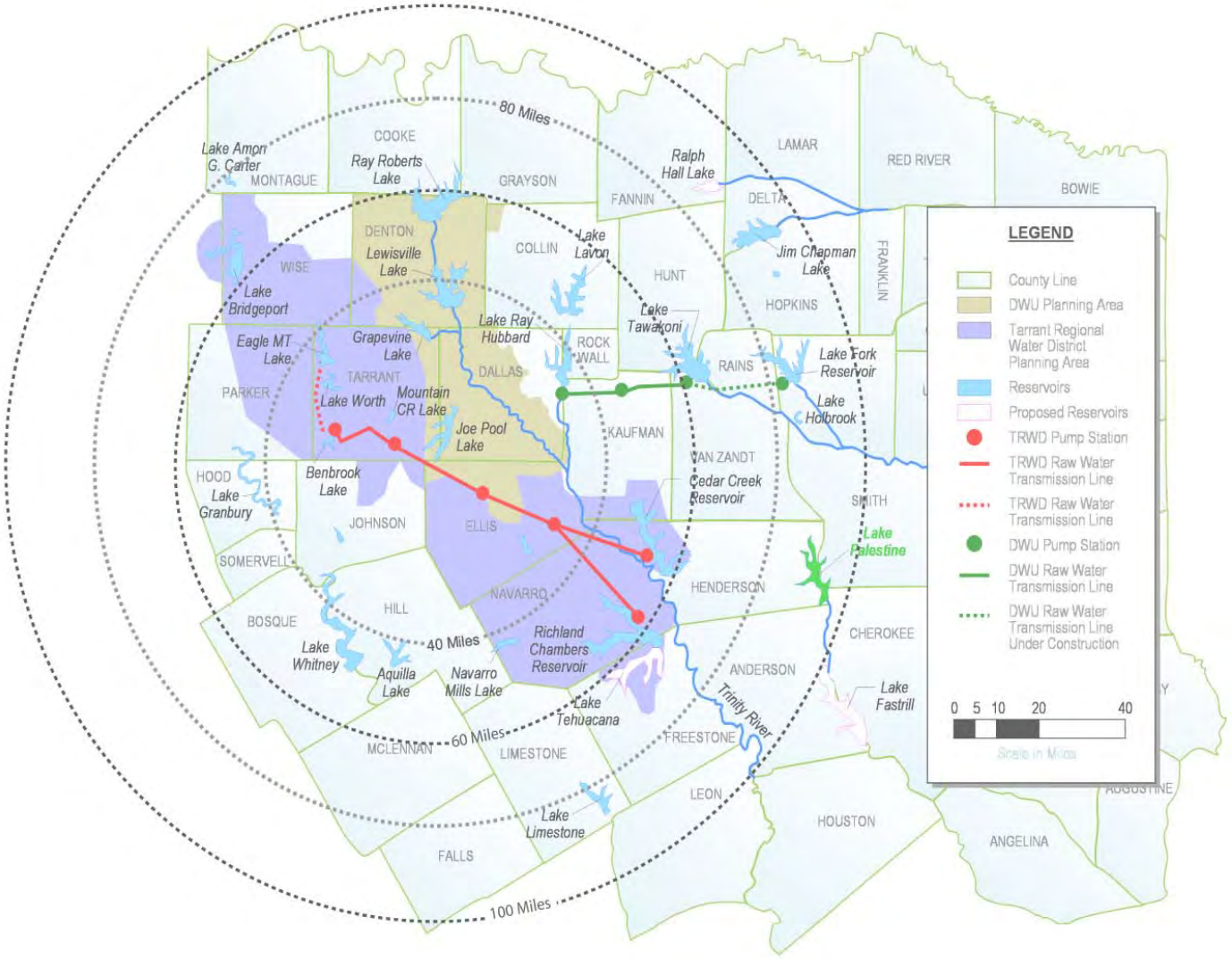


Figure ES-1
Vicinity Map

Several key objectives must be met to make a successful Business Case Evaluation that an integrated system could complement or replace existing, independent water supply plans:

- An integrated raw water transmission system alternative must enhance the redundancy, flexibility, and demand risk management of the existing water supply systems;
- An interconnected plan must make sufficient water supply available to meet demands where and when needed, under a full range of historical hydrological conditions;
- An integrated raw water transmission system alternative must reduce capital and life-cycle costs, while not contributing to unmitigated treatment or distribution costs for DWU or TRWD customers; and
- All scenarios must fully consider societal, environmental, and regulatory complexities

With these key objectives guiding the way, four project conveyance alternatives were developed through a progressive screening approach to evaluate combinations of conveyance infrastructure and interconnections, and by then selecting two Baseline Alternatives (independent water strategies) and the two most promising Interconnection Alternatives (integrated delivery systems), as described in **Table ES-1**. Additional treatment and water transmission facilities for DWU that may be required for an integrated strategy but were beyond the study boundary were also considered in this analysis (see Section 7). **Figure ES-2** maps all pipeline routes used in these project alternatives.

Table ES-1
Project Conveyance Alternatives

Alternative	Description
1 (Baseline)	**Independent Systems**: TRWD's East Texas Third Pipeline and DWU's connection of Lake Palestine to the proposed Southeast Water Treatment Plant
2 (Baseline)	**Independent Systems**: TRWD's East Texas Third Pipeline and DWU's connection of Lake Palestine to Joe Pool Lake
3 (Interconnection)	**Integrated System**: Interconnected Third Pipeline (upsized as compared to the baseline condition) with connection of Lake Palestine to Cedar Creek Reservoir and delivery to DWU at Joe Pool Lake and TRWD's customers through the Third Pipeline
4 (Interconnection)	**Integrated System**: Interconnected "Southern Pipeline" - Lake Palestine delivered to the Lake Benbrook pipeline via a pipeline route to the south of the TRWD Third Pipeline route. Delivery to DWU at Joe Pool Lake and TRWD's customers through connections to the existing system and the Lake Benbrook pipeline.

Conveyance Alternative 4 (Interconnected Southern Pipeline)

Interconnected Southern Pipeline (Alt 4)

Alternative	Description	Diameter (inches)	Length (miles)	Design Flow (with Peaking) (mgd)
4	Southern Pipeline		148	
	Palestine to CC/RC Connections	72	47	128
	CC/RC Connections to Benbrook Pipeline	108	70	331
	CC Connection to Southern Pipeline	72	8	127
	RC Connection to Southern Pipeline	66	8	76
	Southern Pipeline Connection to Joe Pool	108	16	331

Legend
- PS — DWU PumpStations
- PS — TRWD PumpStations
- WTP — WTP Locations
- TRWD Lakes
- Lake Palestine
- DWU Lakes
- Interconnected Southern Pipeline

0 50,000 Feet
1 inch equals 50,000 feet

CDM/KBR

Figure ES-2

Preliminary Findings

Based on the findings of this Project Viability Assessment, **Table ES-2** lists the potential advantages available to both DWU and TRWD if Lake Palestine is delivered through Interconnection Alternatives 3 or 4. The table also provides some explanation of these advantages or disadvantages.

Table ES-2
Preliminary Findings

Potential Interconnection Advantages	Benefit to DWU	Benefit to TRWD	Notes
Reduced Operating Costs	✓	✓	Operating costs within bounded system are lower in interconnected alternatives as compared to baseline alternatives. Savings more pronounced in near term and decrease over time. Near-term savings attributable to full Lake Palestine supply not being required immediately.
Water Sharing, Timing, Phasing	✓	✓	Even under drought conditions in 2020, ~80 additional mgd could be available. Portion of Lake Palestine supply required before 2020 (if DWU demand reaches 102 mgd) but could be phased through 2030. TRWD requires new water supply (above constructed wetlands) between 2030 and 2040. TRWD can sell or trade water and DWU can defer costs. Water sharing possible between both entities in short term, and in long-term during emergency situation or localized drought condition.
Demand Risk Management	✓	✓	Sharing water between the two water providers can help mitigate effects of unforeseen demand growth patterns in the TRWD or DWU systems.
Water Availability	✓	✓	Supply is limited by the permitted amounts, not water availability. During normal hydrologic periods, extra supply is available through 2060 in an interconnected system. Opportunity for both groups to benefit from this water.
Redundancy	✓	✓	Water supplier can select from multiple supply sources in times of emergency, drought, failure, etc. Opportunity for supply and failure risk management. More alternative flow pathways and connections to multiple water and power sources. Impacts of climatic variations are lessened because of diversification of reservoir locations (an interconnected system "casts a wider net").

Potential Interconnection Advantages	Benefit to DWU	Benefit to TRWD	Notes
Operational Flexibility	✓	✓	Multiple flow pathways could be used to transport water. Capitalize on advantageous opportunities for blending of sources, pump cycling schedules, system maintenance and energy management. Potential disadvantage is potential for increased operational complexity Ability to overdraft supply sources provides flexibility to system operations, the potential for lower operating costs, and risk mitigation
Regional Cooperation	✓	✓	Groundwork for interconnecting future water supply sources (Toledo Bend, Oklahoma, etc.), increasing portfolio of water supply options, reducing costs of right-of-way through earlier acquisition, providing financing risk management, facilitation of future interlocal agreements, and compliance with TWDB planning guidelines
Reduction in Life-cycle Costs	✓	✓	[1]Alternative 3 vs. 2: $537,954,000 Savings Alternative 4 vs. 2: $36,644,000 Savings
Reduction in Capital Costs	✓	✓	Alternative 3 vs. 2: $219,394,000 Savings Alternative 4 vs. 2: –$51,919,000
Environmental Water Quality	—	—	A moderate impact related to higher nutrient concentrations from Palestine will not likely affect the designated uses of the receiving reservoirs
Water Treatment Impact	—	—	Low to moderate impact on water treatment at existing and proposed WTP's. Primary impacts relate to Palestine's low alkalinity, high TOC, and high manganese concentrations
Environmental Impacts / Siting Constraints	—	—	No fatal flaws in pipeline corridors, all are potentially viable and can be recommended for further analysis. No significant differentiators between project alternatives in terms of land use, environmental, or technical (engineering) constraints
Permitting and Regulatory Issues	—	—	No fatal flaws.

[1] Interconnected Alternatives 3 and 4 deliver water to Joe Pool Lake. Baseline Alternative 2 also delivers to Joe Pool Lake but Baseline Alternative 1 delivers to the Southeast WTP. Comparisons were therefore made to Baseline Alternative 2 in this summary table because it is the most apt comparison. In subsequent report sections, comparisons with Alternative 1 are provided.

Recommendations

Based on the findings of the Business Case Evaluation in this study, **Table ES-3** summarizes a comparison of positive or negative impacts of interconnection alternatives vs. baseline plans in a Triple Bottom Line Matrix.

Table ES-3
Triple Bottom Line Matrix
Comparison of Interconnection and Baseline Alternatives

Project Element	Economic	Environmental	Social
Capital Costs	+		
Life-cycle Cost	+		+
Water Treatment Implications	–		
Permitting/Constraints	+	–	
Environmental Water Quality		–	
Water Sharing and Timing, Redundancy, Flexibility	+	+	
Regional Cooperation and Future Water Supply	+	+	+
Ellis County Service			+

This study concludes that interconnecting Lake Palestine through the TRWD system is viable – no fatal flaws have been detected in this study – and that the business case is sufficiently strong to recommend proceeding with more detailed study.

Phase II Analysis

The purpose of this study was to compare separate, independently adopted water strategies with integrated raw water delivery system alternatives, and not to select a preferred integration alternative. Though conceptual engineering and operational scenarios were studied in this effort, further analysis is needed to select a preferred integration alternative and to more fully develop how such a joint project would be planned, designed and operated to optimize economic and operational benefits to both systems. This subsequent effort must be initiated quickly due to impending supply constraints and is paramount to support development of institutional agreements and a financing strategy that will be required. It is

recommended that TRWD and the City of Dallas proceed to a Conceptual Design Phase (see Section 9 for additional detail), the purpose of which is to further develop:

- The conveyance alternatives (with more detailed hydraulic and operational analysis);
- The phasing potential of an integrated plan; and
- The cost analysis based on additional conceptual design details.

This will, in turn, support parallel organizational discussions regarding cost- and gain-sharing and the terms of a long-term institutional framework. At the conclusion of the conceptual design phase, both parties should have sufficient decision support to consider moving forward with detailed final design and construction of an interconnected raw water transmission system or independent water supply alternatives.

Data and Limitations

A short list of some of the primary project assumptions and limitations are shown below. Also, some of the key project data are summarized in **Table ES-4** to facilitate the reader's understanding of the size and scope of potential infrastructure.

- All scenarios for independent and joint water management were predicated on the assumption that DWU will utilize the full contractual yield from Lake Palestine (102 mgd) in all future years. This assumption was held constant even if some of the 102 mgd could originate from TRWD water sources in an interconnected system. This assumption was adopted for comparative purposes, and to limit the number of potential scenarios in this fatal flaw analysis by bracketing the results with limits that will not be exceeded when additional detail is added to subsequent analyses.
- This analysis used cost information and methods established in guidelines published by the Texas Water Development Board (TWDB) for use in regional water planning activities. Therefore, cost opinions were screening- or feasibility-level estimates. Unit costs were from 2006 estimates and were inflated to 1st quarter 2008 dollars. Water treatment costs are based on 2008 cost opinions.
- The water quality analysis was based on a mass balance to analyze broad impacts of blending water from Lake Palestine with the different receiving reservoirs.

Table ES-4
Information on Potential Infrastructure

Alternative	Description	Diameter (inches)	Length (miles)	Design Flow (with Peaking) (mgd)
1	Lake Pal to SE WTP	84	88	184
2	Lake Pal to Joe Pool Lake	84	105	184
1 and 2	Baseline Third Pipeline		103	
	Cedar Creek to Ennis PS	72	26	127
	Richland Cambers to Ennis PS	60	30	76
	Ennis PS to Kennedale Bal Res	84	42	203
	Kennedale Bal Res to RHWTP	96	6	203
3	Interconnected Third Pipeline		139	
	Lake Palestine to Cedar Creek	72	35	128
	Cedar Creek to Ennis PS	96	26	255
	Richland Cambers to Ennis PS	60	30	76
	Ennis PS to RH WTP	108	42	331
	Bal Res to RHWTP	126	6	331
4	Southern Pipeline		148	
	Palestine to CC/RC Connections	72	47	128
	CC/RC Connections to Benbrook Pipeline	108	70	331
	CC Connection to Southern Pipeline	72	8	127
	RC Connection to Southern Pipeline	66	8	76
	Southern Pipeline Connection to Joe Pool	108	16	331

Section 1
Introduction

1.1 Project Background

The Tarrant Regional Water District (TRWD) and the City of Dallas Water Utilities (DWU) own or hold water rights or contracts for a combined 14 surface water reservoirs and provide raw water transmission facilities for many cities and water agencies across North Central Texas. Dallas supplies treated and raw water to wholesale customers in Dallas, Collin, Denton, Ellis, and Kaufman Counties. TRWD supplies raw water and transmission services to Tarrant and 8 other counties in Region C and Johnson County in the Brazos G Region. Through 58 wholesale water agencies and cities and the DWU retail water operations, TRWD and DWU provide drinking water to 4.4 million people, a population that is expected to double in the next 50 years.

DWU has water rights for connected and unconnected surface water supplies totaling 1.8 million acre-feet per year or 1,618 million gallons per day (mgd). According to the *Long Range Water Supply Plan 2005 Update,* the actual average daily firm yield projected for 2060 is much less at 582.4 mgd (average daily). According to guidance in the Texas Water Development Board's *Exhibit B – Guidelines for Regional Water Plan Development,* "Firm yield is defined as the maximum amount of water a reservoir can provide each year during a drought of record using reasonable sedimentation rates and reasonable predetermined withdrawal patterns, assuming full utilization of upstream and downstream senior water rights and full satisfaction of environmental flow requirements and bay and estuary requirements if they apply." In general, the drought of record for North Central Texas reservoirs occurred during the drought of the 1950's.

Current population projections and water demand trends as developed in the Region C Water Plan and the 2005 Update of the Dallas Long Range Water Supply, as illustrated in **Figures 1-1a** and **1-1b**, have resulted in a comprehensive list of new water management strategy recommendations which include connecting Lake Palestine to the DWU water system, completion of the TRWD constructed wetlands, and construction of TRWD's Third East Texas Pipeline from Cedar Creek and Richland-Chambers Reservoirs in approximately 2015.

The geographic proximity of Lake Palestine to the existing TRWD water supplies and raw water transmission facilities at Cedar Creek and Richland-Chambers Reservoirs (as shown in **Figure 1-2**) and the similarity between the proposed implementation of these water supply strategies prompted DWU and TRWD to begin preliminary discussions about an opportunity to explore the conceptual feasibility of an integrated approach to bring additional water into the Dallas and Tarrant Regional Water District service areas.

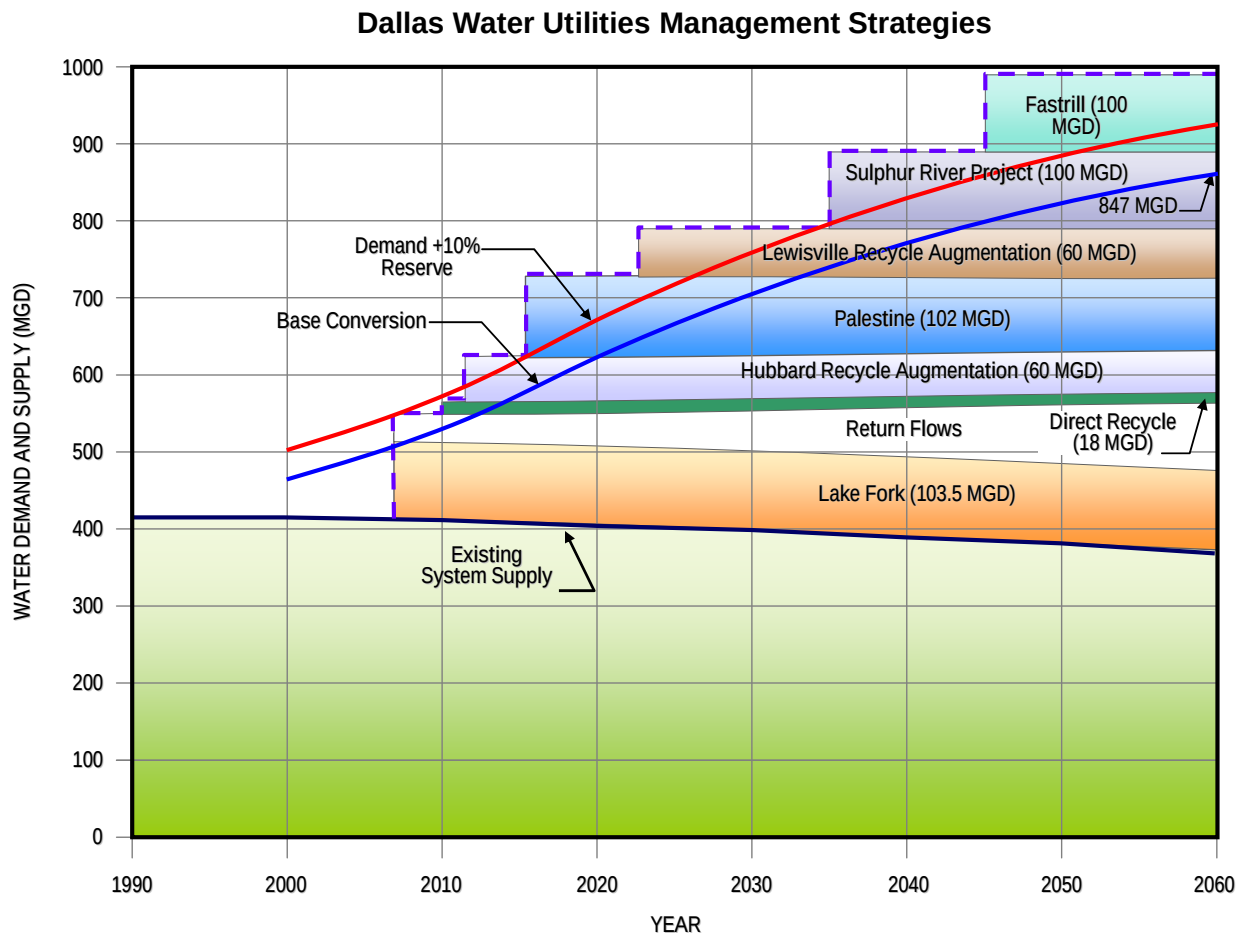


Figure 1-1a
DWU Water Management Strategies
(Figure from December 6, 2006 City Council Briefing)

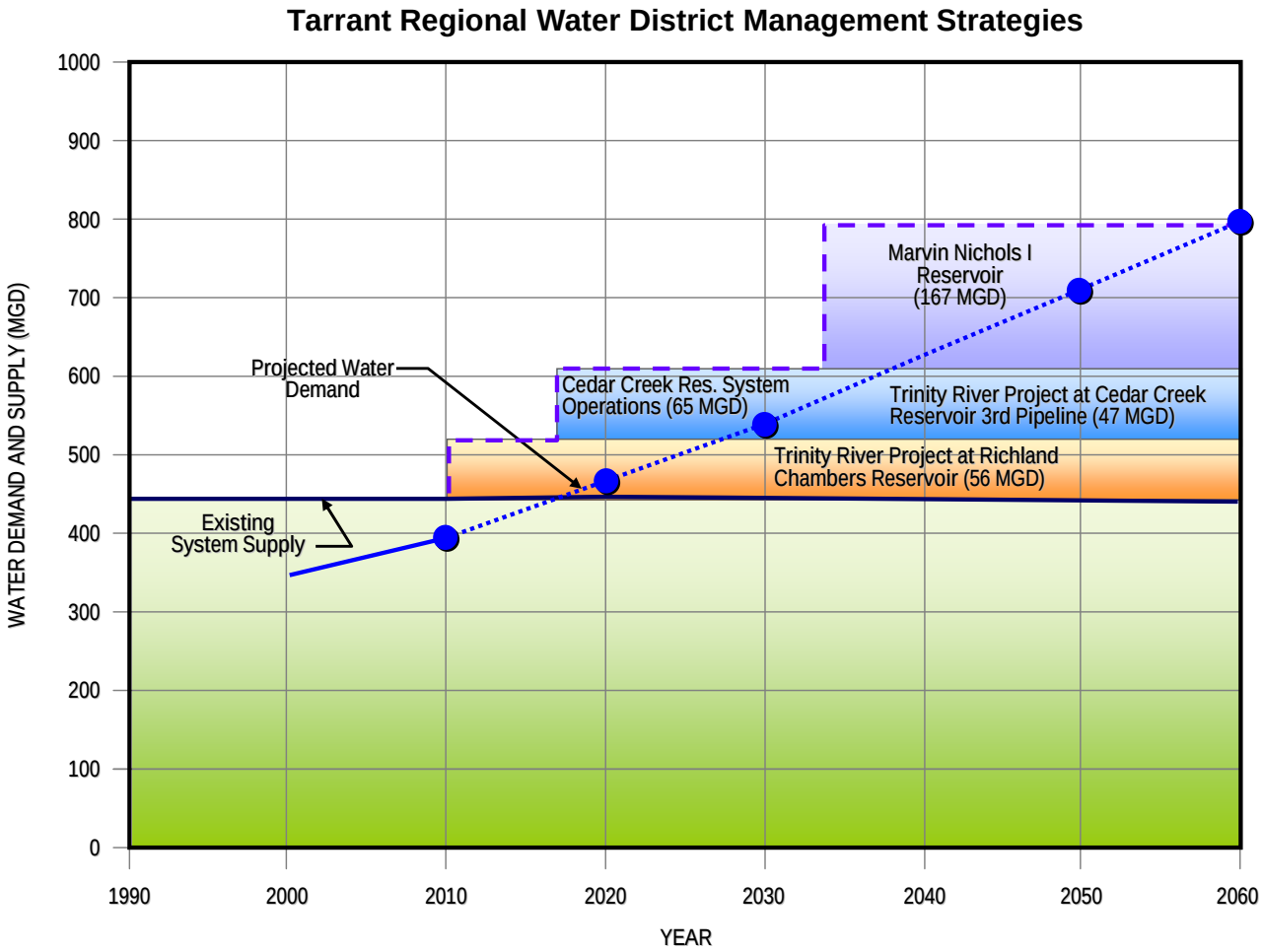


Figure 1-1b
TRWD Water Management Strategies

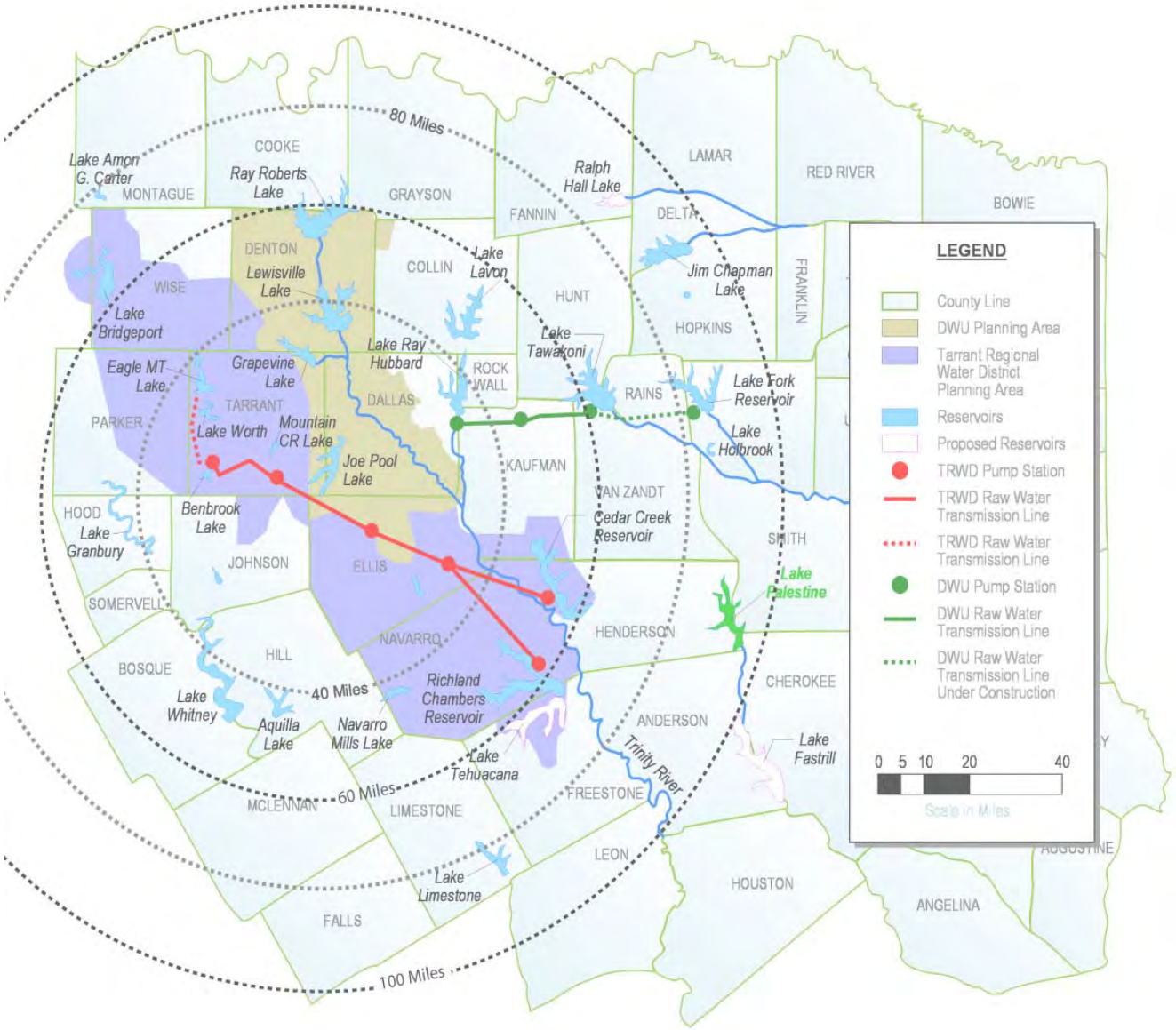


Figure 1-2
Vicinity Map

TRWD and DWU have a long history of cooperation in water supply planning, including the Texas Water Development Board regional water planning efforts initiated by the 1997 passage of Senate Bill 1 in the 75th session of the Texas Legislature. Implementation of Senate Bill 1 led to the creation of 16 regional water planning groups and the development of regional water plans that are updated every five years. The latest adopted regional water plans occurred in 2006 which led to the adoption of the 2007 State Water Plan. This study is intended to complement these ongoing regional plan updates by providing a focused initial project viability assessment and business case evaluation of integrating the TRWD and DWU raw water transmission systems, **Figure 1-2**.

1.2 Project Scope and Purpose

The purpose of this initial Project Viability Assessment and Business Case Evaluation was to 1) identify any "fatal flaws" to developing an integrated raw water transmission system; and 2) compare the separate, independently adopted water strategies of both TRWD and DWU with integrated raw water delivery system alternatives in terms of their life-cycle cost implications, water quality and treatment implications, and permitting and environmental issues. In other words, this study compared the current water supply plans of each agency with integrated raw water transmission system alternatives.

Six tasks were completed as part of this initial Project Viability Assessment and Business Case Evaluation.

1. Integrated system operations analysis;
2. Capital and life-cycle cost analysis;
3. Facility siting constraints assessment;
4. Environmental water quality review;
5. Consideration of water treatment impacts; and
6. Permitting and regulatory review.

Because of their overlapping and correlated purposes, the initial Project Viability Assessment and Business Case Evaluation are not separated in this report though the focus of each was slightly different. The purpose of the preliminary Project Viability Assessment was to identify any potential "fatal flaw" to developing an integrated system using the six tasks listed above; a fatal flaw is defined as a condition that would by itself, or when combined with other constraints, present an unavoidable obstacle that would not allow the project to proceed. The purpose of the Business Case Evaluation was to compare the separate, independently adopted water strategies of both TRWD and DWU with integrated raw water delivery system configurations using a Triple Bottom Line approach that compares the economic, environmental, and social impacts.

Several key objectives must be met to complement or replace existing, independent water supply plans:

- An integrated raw water transmission system alternative must enhance the redundancy, flexibility, and demand risk management of the existing water supply systems;
- An interconnected plan must make sufficient water supply available to meet demands where and when needed, under a full range of historical hydrological conditions;
- An integrated raw water transmission system alternative must reduce capital and life-cycle costs, while not contributing to unmitigated treatment or distribution costs for DWU or TRWD customers; and
- All scenarios must fully consider societal, environmental, and regulatory complexities

With these key objectives guiding the way, four project conveyance alternatives were developed by bounding the study (**Figure 1-3**), using a progressive screening approach to evaluate combinations of conveyance infrastructure and interconnections, and then selecting two Baseline Alternatives (independent water strategies) and the two most promising Interconnection Alternatives (integrated delivery systems), as described in **Table 1-1**. The two Baseline Alternatives represent two strategies in consideration by DWU as an independent supply option; both alternatives deliver water from Lake Palestine but differ in the delivery point (Joe Pool Lake or the Southeast Water Treatment Plant). TRWD may consider constructing a "southern pipeline" route from East Texas to Lake Benbrook as an alternative independent supply option to the Third Pipeline but this possibility was not included as a third Baseline Alternative in this analysis.

Additional treatment and water transmission facilities for DWU that may be required for an integrated strategy but were beyond the study boundary (**Figure 1-3**) are considered in Section 8 of this report. **Figure 1-4** through **Figure 1-7** illustrate the four project conveyance alternatives and **Figure 1-8** shows all pipeline routes used in these project alternatives. A description of the components in these water supply systems follows **Figure 1-8**.

Table 1-1
Project Conveyance Alternatives

Alternative	Description
1 (Baseline)	Independent Systems: TRWD's East Texas Third Pipeline and DWU's connection of Lake Palestine to the proposed Southeast Water Treatment Plant
2 (Baseline)	Independent Systems: TRWD's East Texas Third Pipeline and DWU's connection of Lake Palestine to Joe Pool Lake
3 (Interconnection)	Integrated System: Interconnected Third Pipeline (upsized as compared to the baseline condition) with connection of Lake Palestine to Cedar Creek Reservoir and delivery to DWU at Joe Pool Lake and TRWD's customers through the Third Pipeline
4 (Interconnection)	Integrated System: Interconnected "Southern Pipeline" - Lake Palestine delivered to the Lake Benbrook pipeline via a pipeline route to the south of the TRWD Third Pipeline route. Delivery to DWU at Joe Pool Lake and TRWD's customers through connections to the existing system and the Lake Benbrook pipeline.

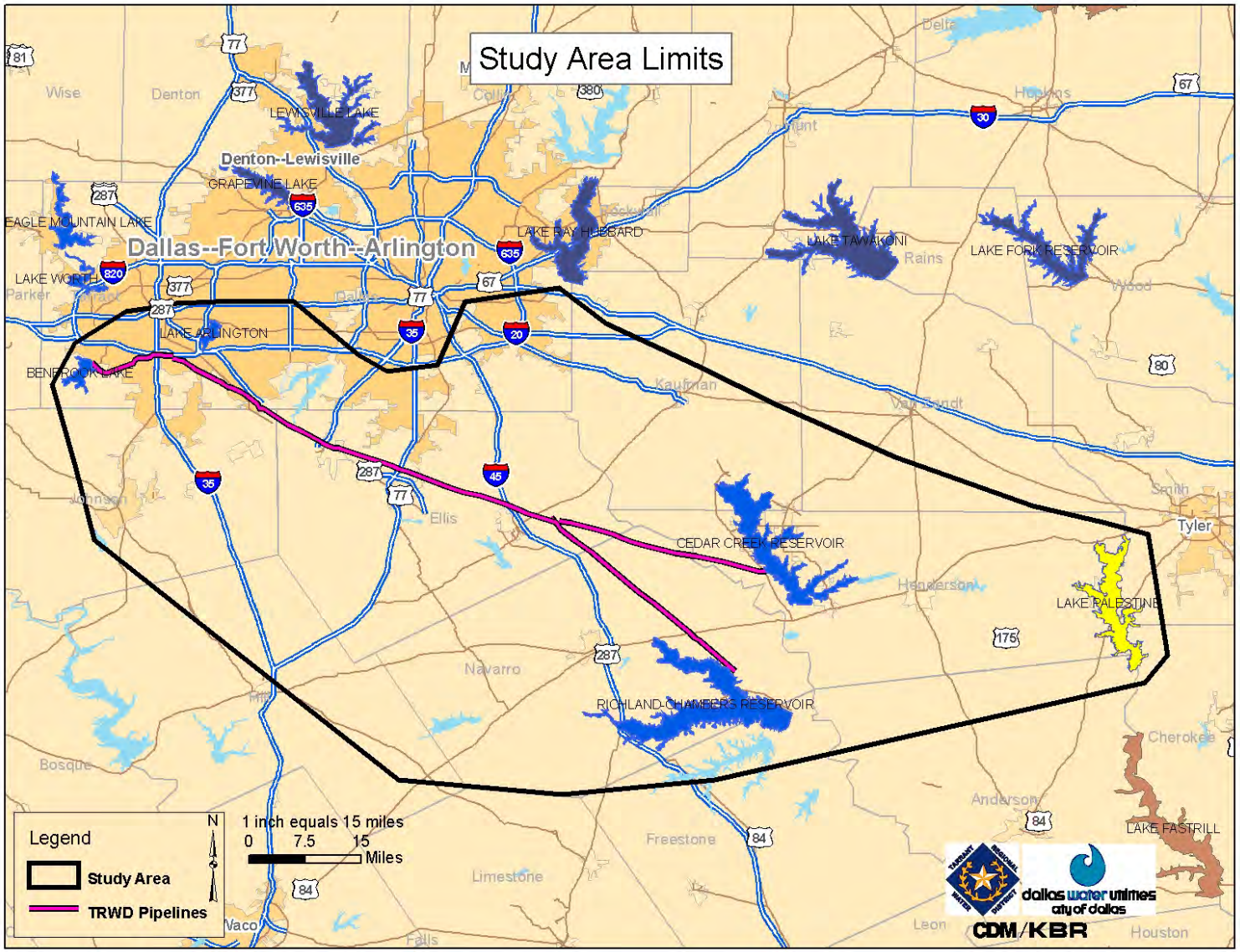
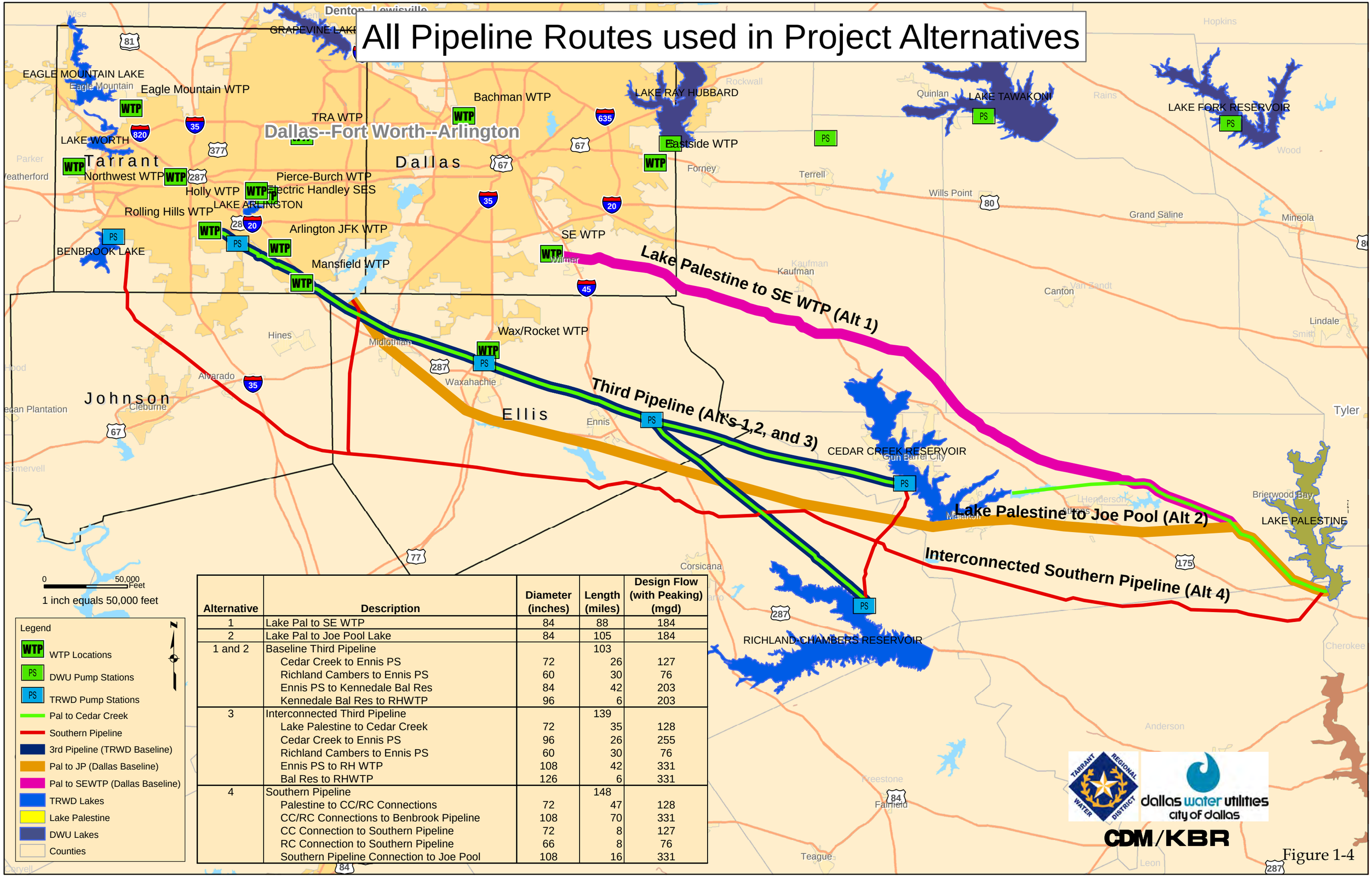


Figure 1-3
Study Area Limits

All Pipeline Routes used in Project Alternatives



0 50,000 Feet

1 inch equals 50,000 feet

Legend

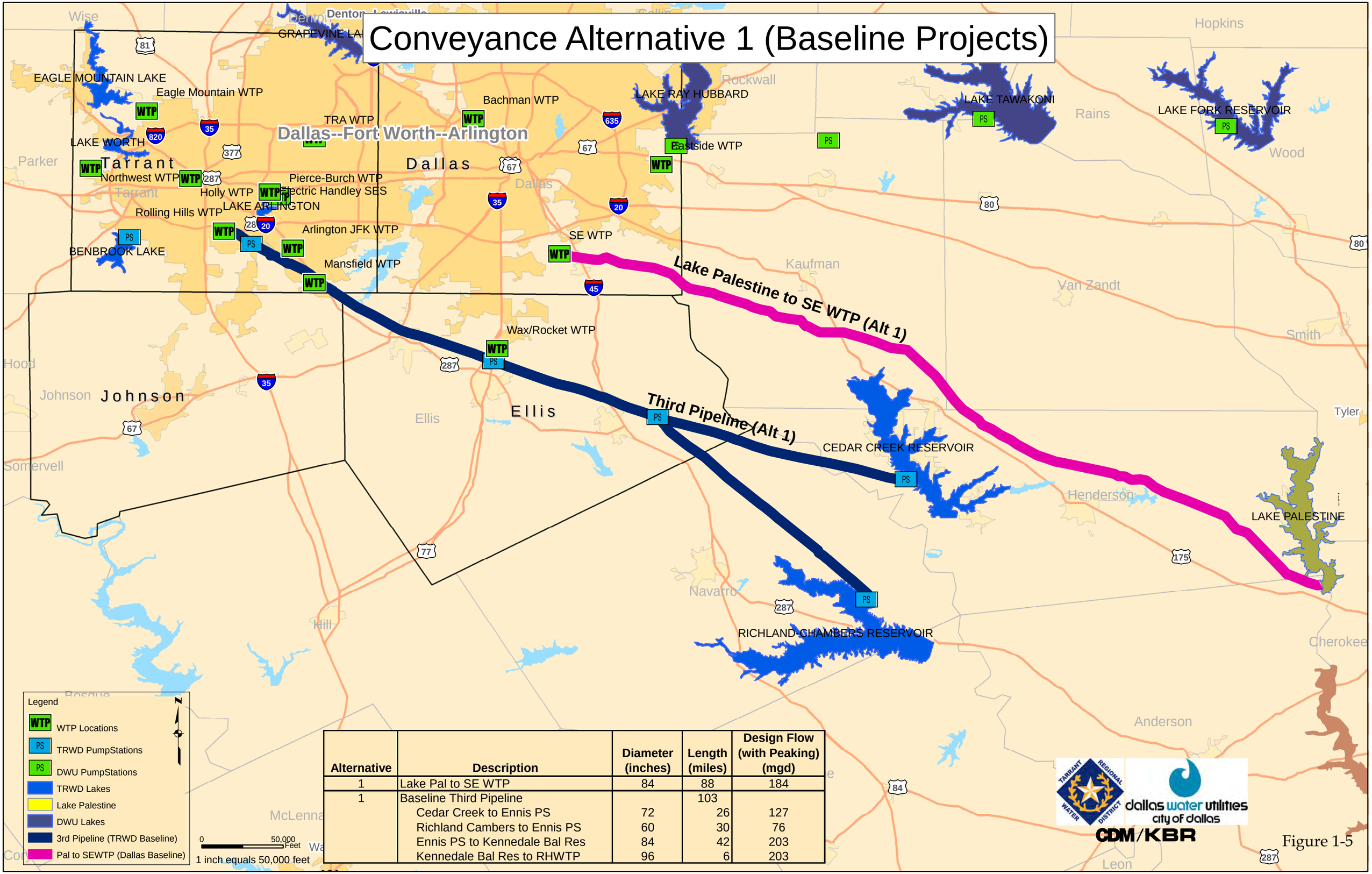
- WTP Locations
- DWU Pump Stations
- TRWD Pump Stations
- Pal to Cedar Creek
- Southern Pipeline
- 3rd Pipeline (TRWD Baseline)
- Pal to JP (Dallas Baseline)
- Pal to SEWTP (Dallas Baseline)
- TRWD Lakes
- Lake Palestine
- DWU Lakes
- Counties

Alternative	Description	Diameter (inches)	Length (miles)	Design Flow (with Peaking) (mgd)
1	Lake Pal to SE WTP	84	88	184
2	Lake Pal to Joe Pool Lake	84	105	184
1 and 2	Baseline Third Pipeline		103	
	Cedar Creek to Ennis PS	72	26	127
	Richland Cambers to Ennis PS	60	30	76
	Ennis PS to Kennedale Bal Res	84	42	203
	Kennedale Bal Res to RHWTP	96	6	203
3	Interconnected Third Pipeline		139	
	Lake Palestine to Cedar Creek	72	35	128
	Cedar Creek to Ennis PS	96	26	255
	Richland Cambers to Ennis PS	60	30	76
	Ennis PS to RH WTP	108	42	331
	Bal Res to RHWTP	126	6	331
4	Southern Pipeline		148	
	Palestine to CC/RC Connections	72	47	128
	CC/RC Connections to Benbrook Pipeline	108	70	331
	CC Connection to Southern Pipeline	72	8	127
	RC Connection to Southern Pipeline	66	8	76
	Southern Pipeline Connection to Joe Pool	108	16	331

CDM/KBR

Figure 1-4

Conveyance Alternative 1 (Baseline Projects)

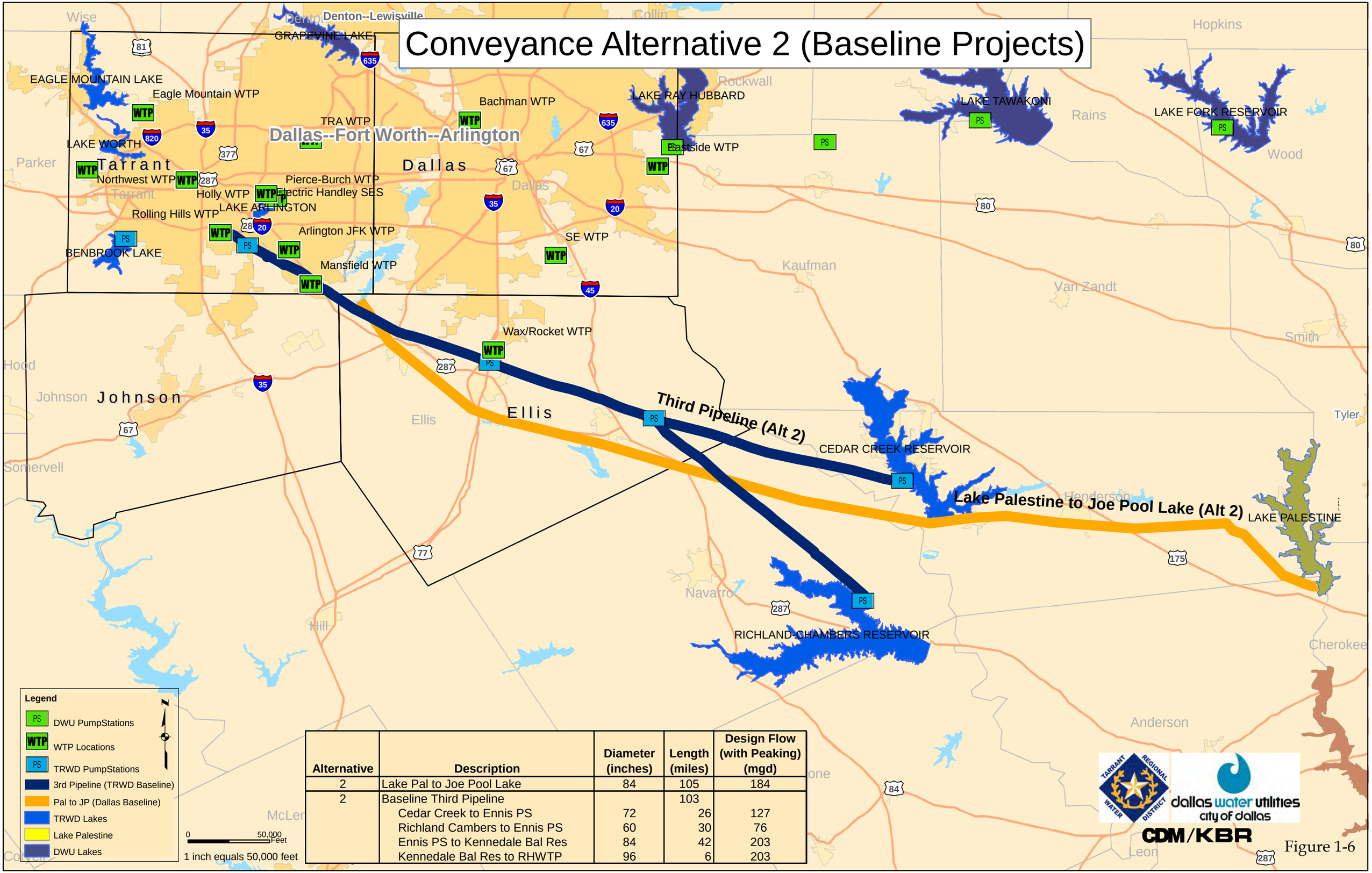


Alternative	Description	Diameter (inches)	Length (miles)	Design Flow (with Peaking) (mgd)
1	Lake Pal to SE WTP	84	88	184
1	Baseline Third Pipeline		103	
	Cedar Creek to Ennis PS	72	26	127
	Richland Cambers to Ennis PS	60	30	76
	Ennis PS to Kennedale Bal Res	84	42	203
	Kennedale Bal Res to RHWTP	96	6	203

CDM/KBR

Figure 1-5

Conveyance Alternative 2 (Baseline Projects)



Alternative	Description	Diameter (inches)	Length (miles)	Design Flow (with Peaking) (mgd)
2	Lake Pal to Joe Pool Lake	84	105	184
2	Baseline Third Pipeline		103	
	Cedar Creek to Ennis PS	72	26	127
	Richland Cambers to Ennis PS	60	30	76
	Ennis PS to Kennedale Bal Res	84	42	203
	Kennedale Bal Res to RHWTP	96	6	203

CDM/KBR

Figure 1-6

Conveyance Alternative 3 (Interconnected Third Pipeline)

Interconnected Third Pipeline (Alt 3)

Alternative	Description	Diameter (inches)	Length (miles)	Design Flow (with Peaking) (mgd)
3	Interconnected Third Pipeline		139	
	Lake Palestine to Cedar Creek	72	35	128
	Cedar Creek to Ennis PS	96	26	255
	Richland Cambers to Ennis PS	60	30	76
	Ennis PS to RH WTP	108	42	331
	Bal Res to RHWTP	126	6	331

Legend
- WTP Locations
- DWU PumpStations
- TRWD PumpStations
- TRWD Lakes
- Lake Palestine
- DWU Lakes
- Interconnected 3rd Pipeline

0 50,000 Feet
1 inch equals 50,000 feet

CDM/KBR

Figure 1-7

Conveyance Alternative 4 (Interconnected Southern Pipeline)

Interconnected Southern Pipeline (Alt 4)

Alternative	Description	Diameter (inches)	Length (miles)	Design Flow (with Peaking) (mgd)
4	Southern Pipeline		148	
	Palestine to CC/RC Connections	72	47	128
	CC/RC Connections to Benbrook Pipeline	108	70	331
	CC Connection to Southern Pipeline	72	8	127
	RC Connection to Southern Pipeline	66	8	76
	Southern Pipeline Connection to Joe Pool	108	16	331

Legend
- DWU PumpStations
- TRWD PumpStations
- WTP Locations
- TRWD Lakes
- Lake Palestine
- DWU Lakes
- Interconnected Southern Pipeline

0 50,000 Feet
1 inch equals 50,000 feet

CDM/KBR

Figure 1-8

1.3 System Descriptions

1.3.1 Lake Palestine

Lake Palestine is owned and operated by the Upper Neches River Municipal Water Authority (UNRMWA) and is located in Region I (East Texas Region) approximately 85 miles southeast of Dallas. UNMWA has contracted to supply up to 114,937 acre-feet per year, (average 102 million gallons per day) to Dallas which holds an interbasin transfer permit to the Trinity River Basin. The 2006 Region C Water Plan recommends as a Water Management Strategy (WMS) that Dallas construct the infrastructure to transport this water from Lake Palestine to Dallas because of its relatively low cost and environmental and permitting risk impact.

1.3.2 Proposed Southeast Water Treatment Plant and Joe Pool Lake

The proposed DWU Raw Water Supply System for the Southeast Water Treatment Plant (SEWTP) would convey Lake Palestine and, possibly in the future, Lake Fastrill, Toledo Bend Reservoir, and other East Texas water supplies to the site purchased for the Southeast Water Treatment Plant. Updated planning level cost estimates have been developed for the raw water transmission facilities needed to transport water to this site for Dallas.

Lake Palestine Spillway

Joe Pool Lake is located on Mountain Creek in the Trinity River Basin in both Dallas and Tarrant Counties. This U.S. Army Corps of Engineers (USACE) reservoir has conservation storage of 176,900 acre-feet. The Trinity River Authority (TRA) has a water supply agreement with the Corps of Engineers and holds the water rights for 17,000 acre-feet per year, or 15 mgd average. According to the Texas Commission on Environmental Quality (TCEQ) Trinity River Water Availability Model (WAM), the available water supply from Joe Pool Lake in 2060 will be 10,000 acre-feet per year. For purposes of this investigation, conveyance alternative 2 and both interconnection alternatives deliver water to the Joe Pool Lake vicinity. Currently Joe Pool Lake serves as a public water supply for the City of Midlothian, which has a water intake structure in the southeast leg of the lake. TRA also has a water intake structure in Cedar Hill State Park, but it is not currently in use. Several other entities have a contractual interest in Joe Pool Lake with TRA but are not currently using it as a drinking water supply.

- City of Grand Prairie – 1,795 acre-feet per year for municipal and domestic uses.
- City of Duncanville – 1,197 acre-feet per year for municipal and domestic uses.

- Midlothian Water District – 6,662 acre-feet per year for municipal and domestic uses

- City of Cedar Hill – 7,346 acre-feet per year for municipal and domestic and industrial uses.

1.3.3 TRWD East Texas Supply

Cedar Creek Reservoir is located on Cedar Creek in the Trinity River Basin in Henderson and Kaufman Counties. The reservoir has 678,900 acre-feet of conservation storage. TRWD holds a water right for diversion of 175,000 acre-feet per year (156 mgd average). According to the TCEQ Trinity River WAM, the available safe yield (synonymous to firm yield except reservoir is left with one year of storage at the end of the critical drought as opposed to zero storage) from Cedar Creek in 2060 will be 175,000 acre-feet per year. TRWD conveys water from Cedar Creek Reservoir through an existing pipeline and will increase conveyance capacity with the proposed Third Pipeline to convey the full 175,000 acre-feet per year and an additional 52,500 acre-feet per year from the Trinity River constructed wetlands.

Richland-Chambers Reservoir is located on Richland and Chambers Creeks in the Trinity River Basin in Freestone and Navarro Counties. The reservoir has 1,135,000 acre-feet of conservation storage. TRWD and the City of Corsicana hold combined water rights in the reservoir totaling 223,650 acre-feet per year with TRWD holding 210,000 acre-feet per year (187 mgd average). According to the TCEQ Trinity River WAM results, the available safe yield from Richland-Chambers will decrease by approximately 35,300 acre-feet per year from 2010 to 2060. However, TRWD analysis has shown that sedimentation rates currently projected in the Texas regional planning models are overstated and that actual rates will have a negligible effect on the safe yield. TRWD conveys supply from Richland-Chambers Reservoir through an existing pipeline and will increase conveyance capacity with the proposed Third Pipeline to convey the full 210,000 acre-feet per year and an additional 63,000 acre-feet per year from the Trinity River constructed wetlands.

The system also includes Lake Arlington, owned by the City of Arlington and ExTx LaPorte, and Lake Benbrook owned by the Corps of Engineers with TRWD holding a contract with USACE and a TCEQ water right permit. Both of these reservoirs provide terminal storage for the District's customers with relatively small yields from upstream runoff. Lake Benbrook is located on the Clear Fork of the Trinity River in Tarrant County and has conservation storage of 72,500 acre-feet; TRWD has a maximum overdraft diversion of 72,500 acre-feet per year on a non-priority basis. Lake Arlington, also in Tarrant County, is located on Village Creek and has 45,710 acre-feet of conservation storage. These terminal storage reservoirs primarily receive waters pumped from Richland-Chambers or Cedar Creek Reservoirs.

The Tarrant Regional Water District also has received a water rights permit from the Texas Commission on Environmental Quality allowing the diversion of return flows of treated wastewater from the Trinity River. TRWD has plans to pump the return

flows from the Trinity River into constructed wetlands and then into Richland-Chambers Reservoir and Cedar Creek Reservoir. This project will provide an additional 115,500 acre-feet per year of new supply. The Region C Plan recommends this relatively inexpensive source of water and the associated raw water delivery facilities of a third pipeline as a preferred water management strategy. For purposes of this study, both the constructed wetlands at the two reservoirs and all the additional conveyance facilities to deliver the constructed wetlands water supply to Richland-Chambers and Cedar Creek Reservoirs are assumed to be complete and in use by 2020.

1.3.4 TRWD West Fork Supply

The West Fork Trinity River portion of TRWD's system includes Lake Bridgeport and Eagle Mountain Lake owned and operated by the District, and Lake Worth owned by the City of Fort Worth. Water from the West Fork of the Trinity River Basin flows by gravity from Lake Bridgeport into Eagle Mountain Lake and then on to Lake Worth. In May 2008 the District completed its Eagle Mountain Connection Project which includes pipelines, pump stations and other facilities to interconnect the District's eastern and western supplies. Through this project, water from Cedar Creek and Richland-Chambers Reservoirs is conveyed to Eagle Mountain Lake.

The volume and rate of water delivered to Eagle Mountain Lake through the Eagle Mountain Connection was included in the modeling. No detailed modeling of the West Fork supply was included in this analysis because integration of the raw water system will not affect the West Fork – it acts as an external demand or supply to the integrated system but it is not requisite to model the disaggregated West Fork supplies in this study.

1.4 Assumptions and Limitations

As described in Section 1.2, the purpose of this initial Project Viability Assessment was to identify any potential "fatal flaw" to developing an integrated system and the purpose of the Business Case Evaluation was to compare the separate, independently adopted water strategies of both TRWD and DWU with integrated raw water delivery system configurations. This is therefore a preliminary, fatal-flaw level analysis with inherent limitations and risk factors. This section captures the principle assumptions and limitations in the six project analyses.

1.4.1 Integrated Operations Analysis

To examine some of the principal differences between routing water from Lake Palestine directly to DWU's terminal points and routing it through new and existing TRWD infrastructure, an integrated system operations model was developed. The model is neither a comprehensive hydraulic model nor a prescriptive day-to-day operations model. *The results from the optimization program should not be construed as a prescriptive approach for future operations, but rather, as a simple means of bounding the theoretical performance of the conveyance alternatives.*

- Operations costs consider only the energy cost in the conveyance system. Routine operations and maintenance is not included and treatment costs are also excluded.

- No adjustments were made to apply downstream release requirements that were not explicitly included in the RiverWare model.

- This optimization model is not intended to function as a hydraulic model. It is intended to provide an understanding of basic delivery requirements necessary to identify energy needs and costs associated with moving water through the system. Calculations for head requirements (elevation and line losses) were conducted outside of the model and these relationships were imported in simplified form so that movement of water incurs costs on a relative basis throughout the system.

- All scenarios for independent and joint water management were predicated on the assumption that DWU requires the full yield from Lake Palestine (102 mgd) in all future years. This assumption was held constant even if some of the 102 mgd could originate from TRWD water sources in an interconnected system. This assumption was adopted for comparative purposes, and to limit the number of potential scenarios in this fatal flaw analysis by bracketing the results. Though other scenarios with varying DWU demand on Lake Palestine water will provide enhanced detail, the fundamental question of the potential opportunities for benefits through integration is captured with this assumption and additional detail will not create results outside of the limits imposed by this assumption.

1.4.2 Capital and Life-Cycle Cost Analysis

The purpose of the cost analysis task was to develop a screening level/conceptual opinion of probable capital and lifecycle cost for each project conveyance alternative and to conduct a present worth economic comparison between the Baseline and Interconnection alternatives. The cost analyses represent total costs for water delivery and do not allocate costs between DWU and TRWD. The capital cost opinions presented herein are based on guidelines established by the Texas Water Development Board (TWDB) for use in regional water planning activities.

These cost opinions are roughly equivalent to a screening- or feasibility-level Class 4 to Class 5 estimate (per AACEI International Recommended Practice No. 17R-97, as shown in **Figure 1-9**).

Spreadsheet cost models were developed to aid in the formulation of a conceptual opinion of probable capital cost for each project scenario. These cost models incorporate planning level engineering design assumptions and a contingency appropriate to this early phase of project definition and development and in consideration of the limited availability of site-specific data.

Capital cost estimates derived from TWDB guidelines for regional water planning include assumptions and inherent uncertainties that may introduce significant

inaccuracies into the analysis. These assumptions and uncertainties will be revisited and refined through subsequent phases of project definition and development. Key assumptions and uncertainties include:

1. The analysis does not include detailed cost engineering to determine probable material and labor costs at the time of construction, possibly five or more years into the future. Unit costs are based on updates from 2002 levels to 2006 levels, prepared by Region C for incorporation into the 2011 water plan. These 2002 cost levels are currently shown in tables in Appendix U of the 2006 Region C Water Plan. For this analysis, Engineering News Record (ENR) cost indexes and U.S. Bureau of Labor Statistics data (Producer Price Index, Material Price Index) were used to escalate the unit costs of pipelines and pump stations, the two largest cost components of each project scenario, from 2006 to 2008.

2. Costs associated with the closure, mitigation and/or relocation of oil and gas wells, environmental mitigation, relocations of existing infrastructure, and other similar design issues cannot be accurately estimated at this stage of project definition and development.

	Primary Characteristic	*Secondary Characteristic*			
ESTIMATE CLASS	LEVEL OF PROJECT DEFINITION Expressed as % of complete definition	END USAGE Typical purpose of estimate	METHODOLOGY Typical estimating method	EXPECTED ACCURACY RANGE Typical +/- range relative to best index of 1 [a]	PREPARATION EFFORT Typical degree of effort relative to least cost of index 1 [b]
Class 5	0% to 2%	Screening or Feasibility	Stochastic or Judgment	4 to 20	1
Class 4	1% to 15%	Concept Study or Feasibility	Primary Stochastic	3 to 12	2 to 4
Class 3	10% to 40%	Budget, Authorization or Control	Mixed, but Primarily Stochastic	2 to 6	3 to 10
Class 2	30% to 70%	Control or Bid/Tender	Primarily Deterministic	1 to 3	5 to 20
Class 1	50% to 100%	Check Estimate or Bid/Tender	Deterministic	1	10 to 100

Notes: [a] If the range index of value "1" represents +10/5%, then an index value of 10 represents +100/-50%
[b] if the cost index value of "1" represents 0.005% of project costs, then an index value of 100 represents 0.5%.

Figure 1-9
Association for the Advancement of Cost Engineering,
Recommended Practice 17R-97; Cost Estimating Classification System

3. Real estate acquisition costs and issues cannot be evaluated at this stage of project development and will undoubtedly impact project cost estimates. In addition to uncertainties regarding the cost of real estate acquisition, capital cost estimates for each project alternative could be impacted if real estate issues dictate transmission system alignments that are longer or are at higher elevations, or both. A more detailed analysis of alternative pipeline alignments will be performed in a subsequent phase of project development. Rates of $3,000 per acre of permanent easement and $1,500 per acre of temporary easement were used (per Region C guidelines).

4. Per direction received in Workshop 1, additional conveyance capacity to accommodate future supply sources to the east was not included in the conceptual design of these systems. Instead, it was assumed that the cost of easements will include right-of-way for pipelines in the project scenarios of this study and additional right-of-way sufficient for one additional pipeline of equal dimensions.

5. In alternatives utilizing the Third Pipeline route, it may be possible to upgrade or expand existing pump stations to accommodate additional capacity. In this analysis, these cost savings were not accounted for in an effort to be conservative.

1.4.3 Future Capital and Life-Cycle Cost Analysis

The purpose of the capital and life cycle cost analysis was to provide preliminary data to allow the sponsors, DWU and TRWD, to make an informed decision as to whether to proceed with further definition and development of a project to integrate water transmission facilities to deliver raw water from Lake Palestine and the TRWD East Texas system. Because of the high-level nature of the analysis, the capital cost estimates and lifecycle cost analyses will need to be refined and updated in subsequent phases of project definition and development. Also, additional analysis will provide more information to differentiate between interconnection alternatives and between baseline and interconnection alternatives. Recommended refinements in the cost analysis are:

- Though phasing opportunities are discussed in section 2 of this report, phasing is not addressed in the cost analyses. However, it could have significant impacts on lifecycle costs, potentially increasing the cost differential between the Baseline and Interconnection scenarios. Specifically, phasing could result in significant reduction of costs associated with the Interconnected Southern Pipeline due to the potential to defer development of transmission facilities required to deliver water to Lake Benbrook. Though phasing could be a proportionally larger benefit in terms of the life cycle costs of the Southern Pipeline, the purpose of this investigation was not to identify a preferred alternative but rather to compare Baseline and Interconnected project scenarios.

- The location of booster and intake pump stations will impact the cost of electricity inasmuch as those facilities could be served by suppliers with lower or higher rates. However, because these locations will likely change on the order of many miles, the energy provider used in this analysis (based on conceptual siting) may change in subsequent phases and updates to cost analyses should include more specific energy cost data as it becomes available.

- Refinements and updates to the capital cost modeling should occur as specific alignments are selected and as the design of facilities progresses.

- These cost analyses represent total costs for water delivery and do not attempt to allocate costs to DWU and TRWD systems. Subsequent phases in this feasibility assessment will address cost and gain sharing.

1.4.4 Constraints Analysis

A preliminary facility siting constraints analysis was performed to identify potential fatal flaws to locating water transmission facilities along select pipeline corridors and to make a comparison between project conveyance alternatives. The preliminary constraints analysis was accomplished using publicly available data from secondary sources with no field data collection. Because additional site-specific data and more detailed analysis will be required in subsequent phases to fully assess potential constraints and impacts, the "opinion of probable impact" will likely be modified as additional data is acquired and pipeline alignments are refined.

The primary components of each of the project conveyance alternatives are transmission pipelines. Though intakes and booster pump stations are also required, the location of these facilities is at a conceptual, approximate level. Because these locations will likely change on the order of many miles throughout the planning and design phases, analyzing constraints to siting pumping facilities was not appropriate at this stage and is reserved for future phases when these locations are less subject to change.

The preliminary findings of the constraints analysis are contained in the Alternatives Evaluation Matrix (AEM), with an analysis of each evaluation criterion and component, and an impact rating for each evaluation criterion. The evaluation is qualitative and will be modified and enhanced as additional data become available and as engineering analyses progress in subsequent phases of project definition and development. It should be noted that the ratings developed in this analysis do not consider several factors, although these factors will be evaluated during subsequent phases:

- Construction schedule;

- Permitting requirements;

- Political favorability;

- Land ownership (data not yet available);
- Operations and Maintenance considerations (beyond cost, which is included in the lifecycle cost analysis); and
- System compatibility and operations.

1.4.5 Environmental Water Quality and Water Treatment Considerations

The purpose of the environmental water quality review was to determine impacts on receiving water quality by the introduction of Lake Palestine water under varying conditions into Lake Benbrook, Cedar Creek Reservoir, Richland-Chambers Reservoir, and Joe Pool Lake. The water quality review included data collection and analysis, mass balance calculations, and a water quality evaluation.

Atrazine data was not available in Lake Palestine or Cedar Creek Reservoir and bromide data was not available in Joe Pool Lake. The majority of the bromide data for Lake Benbrook, Cedar Creek Reservoir, and Richland-Chambers Reservoir included reported values with numerous detection limits. The detection limits were not consistent from reservoir to reservoir and were much higher than the suspected actual concentration. Accordingly, the bromide data were not utilized as part of this environmental water quality evaluation due to the inconsistency of the testing protocols and concerns about the integrity of the available reported data.

The results of this water quality analysis were based on a mass balance of water from Lake Palestine and the receiving reservoir. While this evaluation can provide information that is useful in a planning context by analyzing the broad impacts of blending water from Lake Palestine with the different reservoirs, a more comprehensive analysis should be conducted to provide the level of detail needed for final decision making purposes. The development of hydrodynamic and water quality models would provide the level of detail needed to predict the specific impact on the receiving reservoir.

As noted in the 2006 Region C Water Plan, in general, East Texas reservoirs such as Lake Palestine have higher concentrations of nutrients than the evaluated receiving reservoirs. The ultimate impact of the imported Lake Palestine water with its higher nutrient concentrations is difficult to predict in this evaluation due to the complex kinetic relationships between nutrients and chlorophyll-a. It should be noted, however, that in the Region C Water Plan all of the water management strategies involving importation of water from East Texas were considered to have “low” or medium-low” impacts on the key water quality parameters.

Section 2
Integrated Operations

2.1 Purpose

The purpose of this analysis was to identify opportunities for benefits, or potential disadvantages, to both TRWD and DWU through integrated operations of the raw water transmission systems from Lake Palestine, Richland-Chambers Reservoir, and Cedar Creek Reservoir. This comparison of Baseline Alternatives 1 and 2 with Interconnection Alternatives 3 and 4 (see **Table 1-1**) was driven by a system operations model and the team's water resource planning experience. This model was formulated as a decision-support system that permitted the user to create an array of scenarios that help answer a series of primary and secondary questions, formulated jointly by the project participants during workshops:

Primary Questions

- Can an integrated system offer the same **supply reliability** and an opportunity to lower **operational costs**?
- Are there potential opportunities for **shared water**, and therefore demand risk management**,** in addition to shared conveyance infrastructure?
- Is there an opportunity for greater **redundancy** (and therefore cost and operational risk management) through more **flexibility** in flow pathways and connectivity to multiple sources?

Secondary Questions

- How might the integration of the two systems affect the **timing** needs for various flow pathways and source connections?
- Could **more water** be made available through an interconnected system than through two independent systems?
- What opportunities for **regional cooperation** are made possible by integrated operations?

The modeling team isolated components of the two supply systems that would be most directly affected by the two programmatic alternatives (Baseline or Interconnection) and created an array of scenarios that bounded the opportunities for benefits to both TRWD and DWU. In other words, scenarios were selected to bracket results with an upper and lower bound so that any additional refinements to this analysis will produce results that fall within the bounds identified here. Using these analyses and the team's water resources planning experience, advantages and disadvantages to interconnection were identified in terms of **operational costs** (see Section 3 for capital and lifecycle cost analyses)**, water sharing and timing,**

redundancy, flexibility, and regional cooperation. The following sections describe the modeling approach and conclusions drawn from this analysis.

2.2 Modeling Approach

A detailed modeling plan memorandum was developed in November 2007. This section is intended to provide an overview of the final modeling approach, which followed the original plan with minor adjustments, by briefly discussing tools, techniques, and guidelines. In this way, the results can be understood in their appropriate context.

To isolate components of the two supply systems that would be most directly affected by the two programmatic alternatives (Baseline or Interconnection), and to avoid unnecessary detail associated with subsystems less directly affected, the system was bounded as shown in **Figure 2-1** for modeling purposes. Because not every DWU and TRWD demand node is included in the model, total water user group demand was apportioned between model nodes in the following way:

- **DWU**: The total demand on the modeled system, at either Joe Pool Lake or the Southeast WTP, was Dallas' contracted amount from Lake Palestine, 102 mgd. This isolated the direct impacts of Dallas demand on the conveyance alternatives.

- **TRWD**: Projected demands at each node were extracted from the RiverWare model. To approximate the demand from external nodes on water within the modeled system, the TRWD RiverWare model was used to simulate the West Fork system. These external node demands are initially satisfied by water originating in the West Fork. Water from the modeled system is also delivered to Eagle Mountain Lake.

  West Fork supply is capped by a contractual limitation for normal and drought conditions applicable to the City of Fort Worth. Demand in the West Fork that is not satisfied by West Fork flows is supplied from the bounded system in the optimization model. Water to satisfy monthly targets in Lake Arlington, as well as maintaining minimum conservation pool level at Lake Benbrook; also implicitly represent an internal demand on system water.

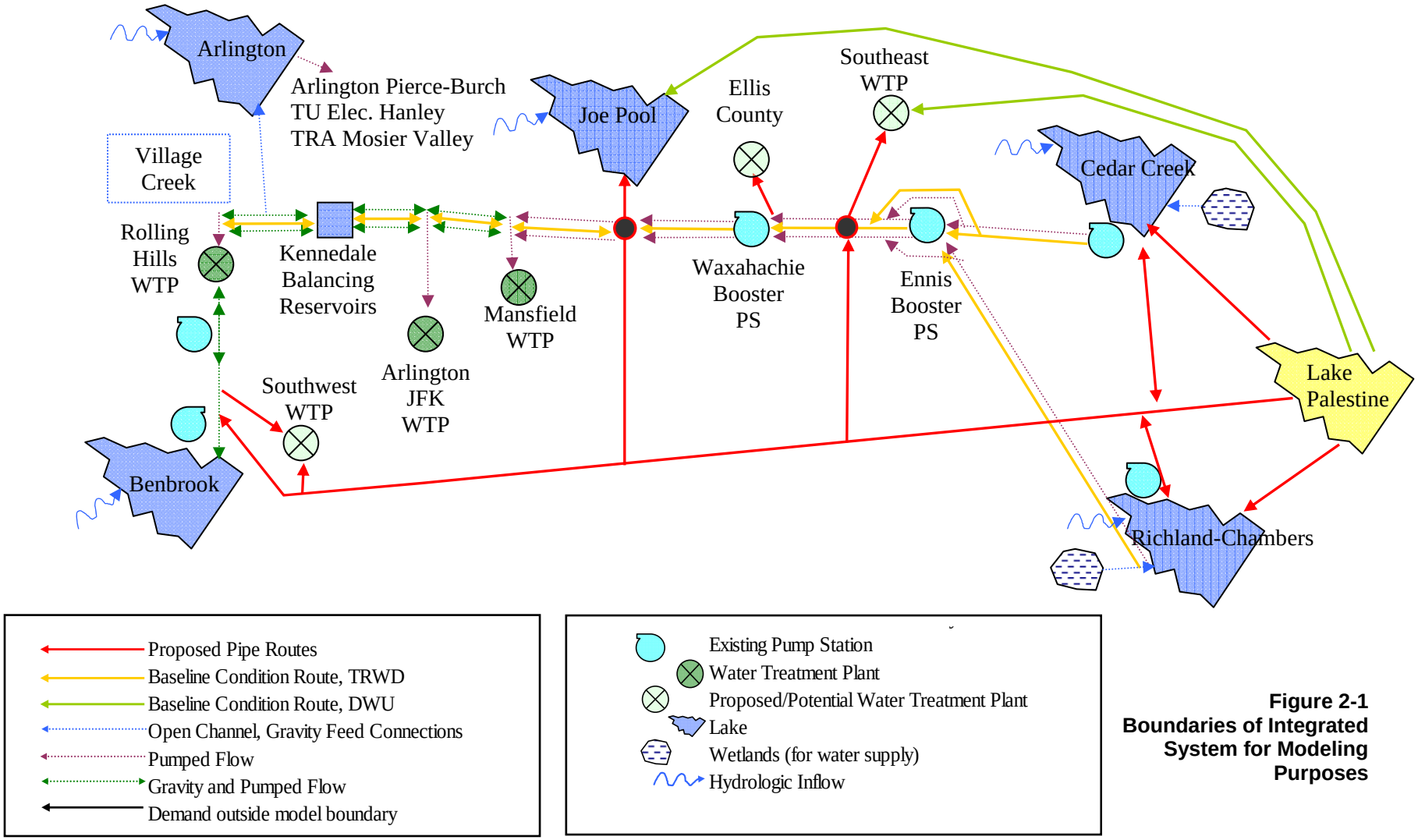


Figure 2-1
Boundaries of Integrated System for Modeling Purposes

- **Ellis County**: Projected demands for Ellis County were based on a combination of Region C 2006 Water Plan projections and the current Region C Four County Study conducted by Freese & Nichols, Inc. These demands were supplied by water available in the bounded system (generally TRWD water in the modeled scenarios).

In addition to the existing infrastructure within its boundaries, the model also included certain TRWD projects that are in the development or construction phase, or have a high probability of being constructed. These included the planned constructed wetlands at Richland-Chambers and Cedar Creek Reservoirs, the recently completed Eagle Mountain Connection from the Rolling Hills Pump Station, and the future Fort Worth Southwest Water Treatment Plant.

In general, the model was formulated on three basic tenets, described in more detail in the sections below:

- Water distribution priorities and cost calculations establish a basis for **comparison**, **not allocation** between the two entities.
- The model was formulated to focus on opportunities and costs.
- Existing operating rules were suspended (except as discussed in section 2.2.3) and the optimization program was used to suggest effective operational practices and priorities.
- The model relied on existing data sources and models (such as TRWD's RiverWare model).

2.2.1 Water Distribution and Cost Calculations

Because the purpose of this modeling was to compare Baseline and Interconnected scenarios, modeling protocols were established to provide commonality between scenarios. These protocols did not represent actual operating agreements or allocate operational costs to individual entities. Instead, they established priorities for water distribution so that the modelers could experiment with the potential for water sharing and operational cost reduction. Results indicate opportunities, not designs.

A primary modeling protocol related to demand and the distribution of water. In Baseline scenarios (independent systems), DWU's demand and allocation from Lake Palestine were 102 mgd at all times and there was no access to TRWD supplies; though the supply reliability of the DWU raw water delivery system will decrease over time as additional water supplies are required, the overall Dallas system was not modeled (in order to emphasize the elements most directly affected by interconnection) and only the 102 mgd from Lake Palestine was included. In a Baseline scenario therefore, DWU always received 102 mgd and the model was used to optimize operating costs. In the Baseline TRWD scenario, it had sole access to its

supplies and the model considered the entire TRWD system (portions of which are only external demands to the pieces modeled in detail). The model was therefore used to calculate operating costs and supply reliability decreases over time as additional water supplies are required.

In Interconnected modeling scenarios, the model considered the potential for water delivery from Lake Palestine or any portion of the TRWD system to be the same. The purpose of the model was to therefore explore the potential for cost savings, redundancy, water sharing, and etc. by optimizing in a two-step process – first the reliability of deliveries to TRWD and DWU, and second optimizing the operational costs of that "highest reliability" run by iterating on alternative delivery pathways.

The first step required "prioritization" of deliveries to three entities: TRWD, DWU, and Ellis County. Because interconnection presents no advantage to DWU if it can no longer access the 102 mgd available in an independent system, the model ensured delivery of the full 102 mgd to DWU. This also assumes that the DWU demand does not gradually increase but rather is the entire 102 mgd from Lake Palestine. Because interconnection presents no advantage to TRWD if supply reliability is lower in an integrated system than an independent system, the model then optimized TRWD's reliability, which will still decrease over time because additional water supplies were not added to the model at the decade they are required in the future; the purpose was therefore to ensure that the hydraulic capacity is available to at least match the reliability it would produce under baseline conditions, not to ensure 100% reliability in the future. After these two supplies were optimized, the model allocated additional water supplies to Ellis County.

2.2.2 Primary Focus on Opportunities and Costs

The model was formulated to help identify opportunities for operational cost savings (see Section 3for capital and lifecycle cost analyses), water sharing and timing, redundancy, flexibility, and regional cooperation associated with an interconnected system. To fully explore the potential for such a system, most existing operating rules were suspended and the model employed an optimization program to route water through the system segments in a manner that would minimize deficits at demand nodes, and to do so at the lowest estimated operating costs. The system was constrained by pipeline capacities, reservoir storage, and water availability, and conveyance costs were computed on a monthly basis for each reach in the system (as shown in **Figure 2-1**).[1]

2.2.3 Simplified Operating Rules

The optimization program was used to suggest effective operational practices and priorities (such as when to draw from Lake Palestine, for example). Though the operating rules of the existing system were not enforced[2], the following operating

[1] See section 1.4.1 for limitations to the integrated operations model.
[2] This was done to avoid the potentially artificial restrictions of applying existing operating protocols to an integrated system that as yet does not exist.

rules were used in an effort to maintain general continuity with well-established existing protocols:

- Flow between points connected by more than one pipeline was divided equally between the pipes (on a capacity percentage basis).
- Existing conservation pool limits were enforced.
- Monthly minimum targets elevations for Lake Arlington were enforced. (540 feet from June- September, 535 feet October – May). Other reservoirs were operated within their specified conservation pools. These targets were found to have only a minimal influence on overall results.
- The model allowed scenarios to be formulated with or without the existing permitted yield constraints on Cedar Creek, Richland-Chambers, and Benbrook Reservoirs (these constraints accounted for contributions from proposed TRWD wetlands to Richland-Chambers and Cedar Creek Reservoirs). Pass-through water from Lake Palestine was also added to existing permitted yield constraints for Richland-Chambers and Cedar Creek where applicable. TRWD indicated that sedimentation rates projected in the Region C planning process for TRWD reservoirs appear to be overstated and actual rates will have a negligible effect on yield. As a result, sedimentation in the reservoirs was not accounted for in the optimization model.
- Holly WTP and Eagle Mountain WTP were supplied water from both the modeled East Texas system and the West Fork Trinity River. The City of Fort Worth, by special conditions in their water rights, was limited to take no more than 100,000 acre-feet per year from the West Fork. During drought conditions, defined as when the West Fork reservoirs (Lake Bridgeport, Lake Worth, and Eagle Mountain Lake) are at less than 50% capacity, the limit was reduced to no more than 46,000 acre-feet per year. These limits were enforced within the model by exporting the demand delivered by the West Fork to each WTP from the RiverWare model, then applying the remainder of the total projected demand for each WTP to the appropriate node in the model.

2.2.4 Reliance on Existing Models

Monthly demand values for each TRWD node within the model were extracted directly from the existing TRWD RiverWare model. Likewise, the hydrologic inflows to each reservoir within the bounded system were extracted directly from RiverWare. Because the DWU demand is bounded by the Lake Palestine yield, no additional data was required from an existing DWU system model.

2.3 Array of Operational Scenarios

The model allowed the formulation of a variety of scenarios, as shown on the screen capture of the model's interface screen in **Figure 2-2**. Various segments of the conveyance infrastructure were activated or deactivated for each scenario, allowing

the model to examine how best to utilize each pathway, and which ones would likely be most cost effective. Each scenario spanned a seven-year period on a monthly timestep and water availability was selected to represent comparatively normal conditions, or the drought of record. Hydrology was superimposed on future demand projections for TRWD and DWU through 2060.

The nearly endless array of possible scenarios was limited to those that clearly provided decision support regarding advantages or disadvantages of investing in infrastructure jointly or separately. These scenarios revealed opportunities for operational cost reductions, water sharing and timing, redundancy, and flexibility. These opportunities were tested for two conditions imposed on the model: permitted yield constrained and system operations. In the permitted yield constraint models (somewhat akin to a "firm yield" condition), the system is limited by conveyance capacity and all water supplies are limited by the lesser of their contracted/permitted amounts or firm yield amounts as defined by TCEQ. In the system operations condition, the model was constrained by lake levels, conveyance capacity and climate, but not by contracted/permitted values.

The following list explains the primary variables used to formulate each scenario:

- Conveyance Alternative: the four conveyance alternatives in **Table 1-1** were used to distinguish costs and benefits between baseline and interconnected alternatives.

- Optimization Objectives: Most scenarios were optimized to yield the highest supply reliability, and then, using those reliability targets, optimized to yield the lowest operational cost. In some experimental scenarios, the model was not optimized for cost because it did not contribute information needed to make decisions based on those particular scenarios.

- To test the impact of the TRWD constructed wetlands, capacity was set to full permitted amounts or zero.

- DWU demand: in experimental scenarios used to test the potential for water sharing, the DWU demand was prioritized behind TRWD and Ellis County and set at 1,000 mgd (essentially unlimited) and set at 0 mgd to test water sharing potential for TRWD.

- Application of existing permitted supply constraints. The model allowed scenarios to be formulated with or without the existing permitted yield constraints on Cedar Creek, Richland-Chambers, and Benbrook Reservoirs.

- Demands could be set by decade between 2010 and 2060.

- Hydrologic Condition: Each alternative could be tested during drought or normal hydrologic conditions.

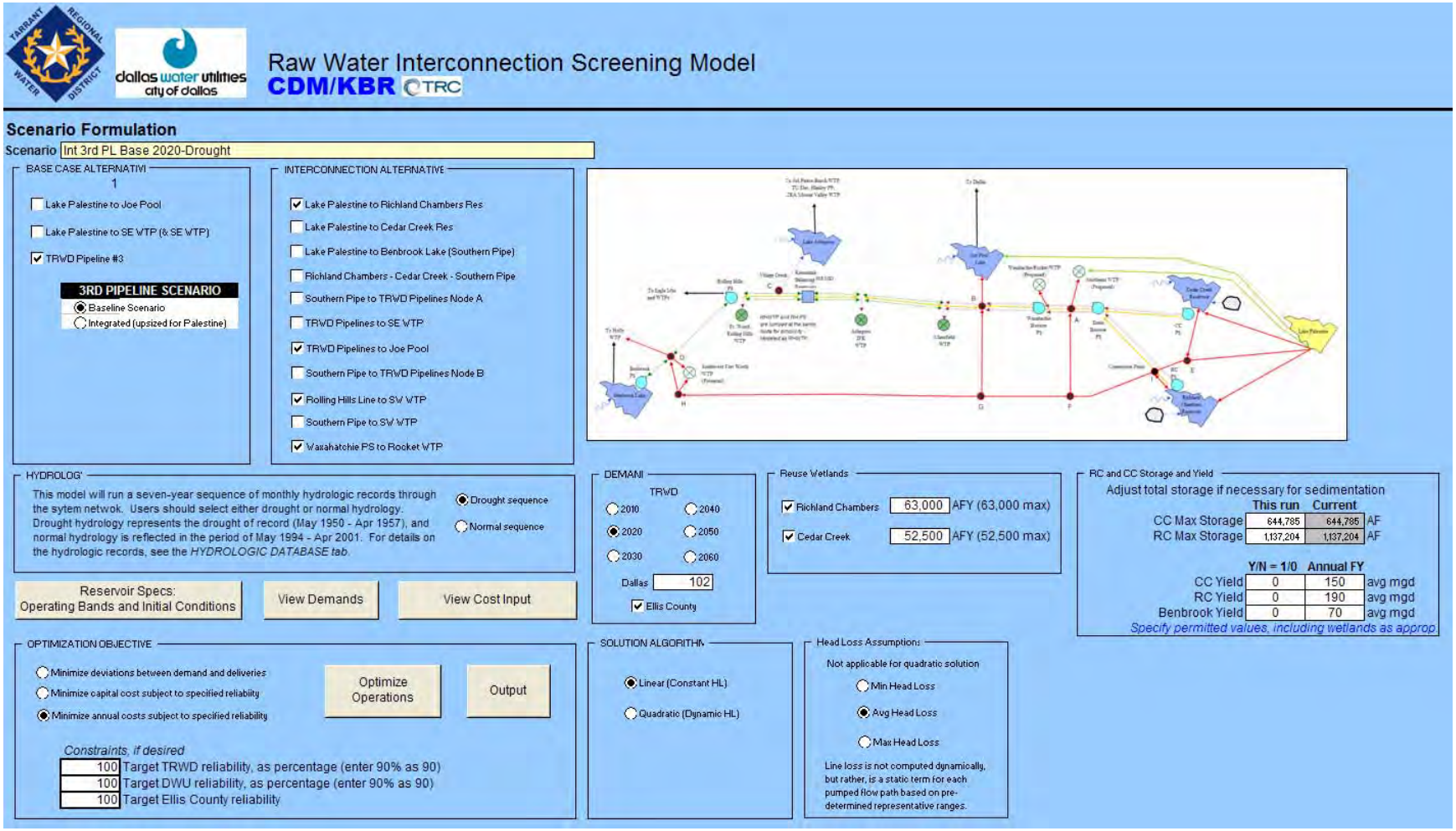


Figure 2-2
Scenario Formulation Interface

2.4 Conclusions from Integrated Operations Analysis

The purpose of this analysis was to identify opportunities for benefits, or potential disadvantages, to both TRWD and DWU through integrated operations of the raw water transmission systems from Lake Palestine, Richland-Chambers Reservoir, and Cedar Creek Reservoir. This comparison of Baseline Alternatives 1 and 2 with Interconnection Alternatives 3 and 4 (see **Table 1-1**) was driven by a system operations model and the team's water resource planning experience. This model was formulated as a decision-support system that permitted the user to create an array of scenarios that help answer a series of primary and secondary questions, formulated jointly by the project participants during workshops:

In this context, we can conclude the following regarding operating costs, water sharing and timing, redundancy, flexibility, and regional cooperation:

2.4.1 Operating Costs

As illustrated in **Figure 2-3**, the integrated operations modeling shows that operating costs within the bounded system (see **Figure 2-1**) are lower in interconnected alternatives as compared to baseline alternatives. This opportunity for operational cost savings is more pronounced in the near term and decreases over time as the difference between interconnected and independent operations is minimized. This near-term savings is attributed to the fact that the full amount of DWU water supply from Lake Palestine is not required immediately. (DWU access to the TRWD supply system could extend the need to connect the Lake Palestine supply to each system.)

2.4.2 Water Sharing and Timing

The integrated operations modeling found that there is opportunity to make extra water available to water user groups via an interconnected system. The analysis suggests that even under drought conditions in 2020, approximately 80 additional mgd could be available. This result is based on three modeling protocols: 1) water availability is limited by existing TRWD permits (for Richland-Chambers, Cedar Creek, and the planned wetlands); 2) DWU demand is equal to the contracted amount in Lake Palestine (102 mgd); and 3) conveyance is limited by the capacity of existing and planned TRWD conveyance facilities.

This result also confirms that Lake Palestine supply will be required prior to 2020 if the DWU demand reaches 102 mgd (though not all of it will be required immediately and dependence upon it as a source could conceivably be phased). Additions to conveyance capacity could be phased through 2030. TRWD requires water supply in addition to sources already included in the model, such as the reuse wetlands, between 2030 and 2040 (based on existing permit constraints and projected demands).

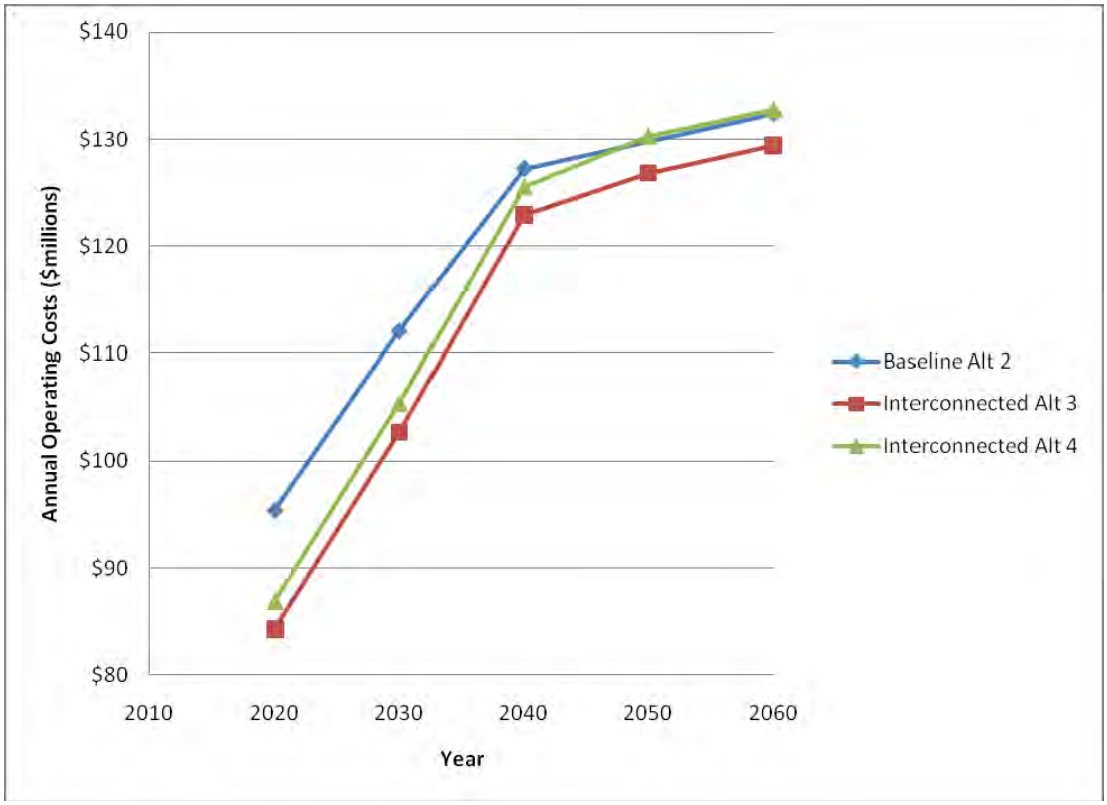


Figure 2-3
Summary of Operational Cost Opportunities Under Drought Conditions

Interconnection also provides the opportunity for TRWD to use the 102 mgd from Lake Palestine. This water sharing may be useful in an emergency situation or in a localized drought condition that causes deficit in the TRWD system while excess is available to DWU. This opportunity to share water between the two water providers is also a method of demand risk management to mitigate the effects of unforeseen demand growth patterns in the TRWD or DWU systems.

By the year 2030, any configuration of the system becomes supply limited, and reliability predictions during severe droughts would be roughly equivalent among configurations. However, during normal hydrologic periods, extra supply is available through 2060 in an interconnected system, though TRWD may have conveyance limitations to accessing the water. The analysis also indicates that the TRWD system can support sustained withdrawals above the current permitted levels. In other words, supply is limited by the permitted amounts, not water availability.

With an interconnected system, any additional water above projected demands would conceivably be available to any water user group, provided that conveyance capacity would be adequate. With separate systems, this water would not be available to DWU and TRWD and its customers would not benefit from potential sales or trades of water above projected TRWD customer demands. With an interconnected system, there is also the possibility of bringing other, currently independent sources (such as

DWU reuse water) and new water supply sources (Toledo Bend, Oklahoma, etc.) into the interconnected system to enhance the potential for water sharing.

To satisfy the DWU demands as they are represented in the model, the full yield of Lake Palestine (102 mgd) is needed immediately if the two systems remain separate. If conveyance systems are interconnected, use of Lake Palestine could ramp up gradually (assuming TRWD water supply in excess of projected demands could help satisfy DWU demand). This offers significant benefits with respect to phased infrastructure that are not available with separate systems.

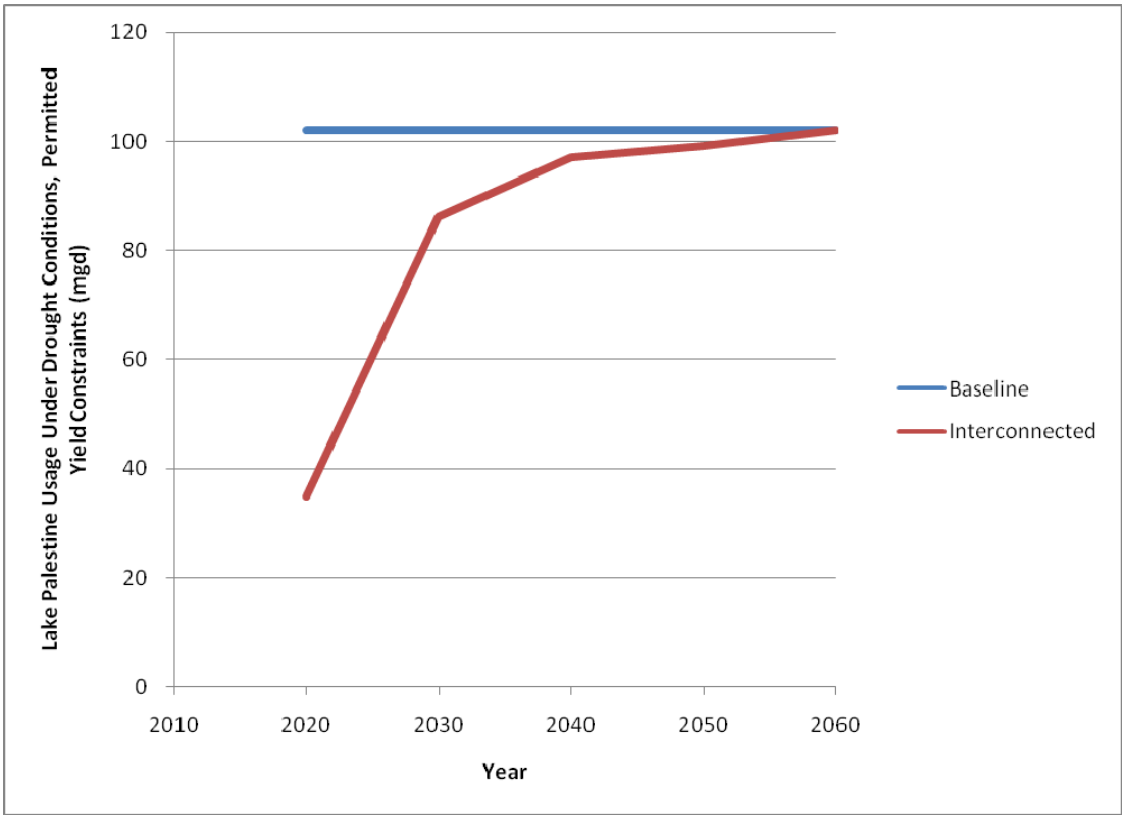


Figure 2-4
Potential Impact on Lake Palestine Timing (Assuming DWU Demand Constant at 102 mgd, Drought Conditions, Permitted Yield Constraints)

2.4.3 Redundancy

Operational redundancy is a "belt and suspenders" approach to risk management that enables the water supplier to select from multiple supply sources in times of emergency, drought, failure, etc. An interconnected supply system therefore provides more opportunity for supply and failure risk management.

In the event of a pipe failure or power outage, an integrated transmission system has more alternative flow pathways and connections to multiple water and power sources. These additional connections lower risk to the water provider. The impacts

of climatic variations are also lessened because of the diversification of reservoir locations. An interconnected system "casts a wider net" to reservoirs in different watersheds that will potentially experience drought in different times or levels of severity. Also, access to additional sources that may not be fully utilized adds supply redundancy to the system.

2.4.4 Operational Flexibility

Under prevailing ("normal") hydrologic conditions when the modeled system is not supply-limited, an interconnected system offers more operational flexibility than separate sources, since multiple flow pathways could be used to transport water. Such flexibility could be used to capitalize on advantageous opportunities for blending of sources, pump cycling schedules, system maintenance and energy management. One potential disadvantage of operations in an integrated system is the potential for increased operational complexity and the attendant new systems and protocols that must be developed to manage such a system.

The interconnected system also provides flexibility in terms of water availability. Extra supply is available through 2060 in an interconnected system and the analysis indicates that the TRWD system can support sustained withdrawals above the current permitted levels. This ability to overdraft supply sources provides flexibility to system operations, the potential for lower operating costs, and risk mitigation.

The National Water Research Institute in its November 2007 white paper entitled "Water 2010: A 'Near Sighted' Program of Water Resource Management Improvements for the Western United States" recommended system interties as its number one action item for state and local policymakers. NWRI concluded that "System interties increase the flexibility of system operators to respond to weather events, natural disasters, contaminations incidents, or the need to take water treatment or conveyance facilities temporarily off-line for repair or refurbishment……many interconnections can be planned and constructed within just a few years and at a relatively low cost."

2.4.5 Regional Cooperation

TRWD and DWU have a long history of cooperation in water supply planning, including the Texas Water Development Board regional water planning efforts initiated by the 1997 passage of Senate Bill 1 in the 75th session of the Texas Legislature. This on-going cooperation has led to this study and the potential for raw water transmission system interconnection. The interconnection of the two systems provides opportunities for benefit to both agencies by laying the groundwork for interconnecting future water supply sources (Toledo Bend, Oklahoma, etc.), increasing the portfolio of water supply options, reducing the costs of right-of-way through earlier acquisition, providing financing risk management, and compliance with TWDB planning guidelines.

The groundwork for regional cooperation in accessing future water supply options has already been laid; integrated water supply infrastructure provides additional opportunity for cost savings and will facilitate future inter-local agreements. By interconnecting the transmission system, each agency also effectively increases its portfolio of water supply options through the potential to share water and infrastructure.

Escalating costs for right-of-way acquisition (and urbanization) also point to the benefits of securing transmission routes early. This early acquisition presents an opportunity to acquire sufficient right-of-way for future joint water supplies. TRWD has recently experienced the following average costs for securing easements for several large diameter transmission system projects, costs which raise the issue of expedited acquisition of right-of-way for this and other future joint projects:

- Real estate classified as rural - $15,415 per acre.
- Real estate classified as undeveloped, planned - $33,792 per acre.
- Real estate classified as developed - $71,247 per acre.

Escalation in the cost of materials and ever increasing pressure on the financing market also point to the benefits of interconnection. Economies of scale and the ability to leverage the joint financing capacity of both agencies are benefits in integration.

Along with the other opportunities for benefits through integration, this regional cooperation is in compliance with TWDB guidelines for water supply planning. These guidelines and the TWDB planning process require this cooperation.

2.5 Summary Conclusion

From an operational perspective, the analysis supports further investigation of interconnected conveyance alternatives. Unlike separate systems, an interconnected system that routes Lake Palestine through the planned TRWD system offers reduced operating costs, cost sharing, savings due to infrastructure phasing, opportunities for water sharing, the potential for increased overall system yield and supply reliability, redundancy, and operational flexibility with respect to infrastructure scheduling and daily operations.

These results indicate a broad range of potential benefits that could be realized with an interconnected system as opposed to separate systems. Subsequent sections of this report address other factors relevant to interconnections, such as water quality, treatment requirements, environmental impacts, etc. Subsequent phases of work will establish operating protocols and cost agreements for shared conveyance and shared supply, and will address permitting needs.

Section 3
Lifecycle Cost Analysis

3.1 Purpose

The purpose of this cost analysis task was to develop a screening level/conceptual opinion of probable capital and lifecycle cost for each project conveyance alternative and to conduct a present worth economic comparison between the Baseline and Interconnection alternatives. The cost analyses represent total costs for water delivery and do not allocate costs between DWU and TRWD. The capital cost opinions presented herein are based on guidelines established by the Texas Water Development Board (TWDB) for use in regional water planning activities. The primary deviation from the TWDB guidelines is that the lifecycle cost analyses presented below consider escalation in power, operations and maintenance, and replacement costs while the TWDB guidelines specify development of a current (i.e., non-escalated) estimated annual cost for use in comparisons of alternative water management strategies.

The four project conveyance alternatives (described in **Table 1-1** and reproduced below for the reader's convenience) were compared in this cost analysis. The reader should refer to **Figures 1-4** through **1-8** for maps of pipeline routes used in each conveyance alternative.

Alternative	Description
1 (Baseline)	Independent Systems: TRWD's East Texas Third Pipeline and DWU's connection of Lake Palestine to the proposed Southeast Water Treatment Plant
2 (Baseline)	Independent Systems: TRWD's East Texas Third Pipeline and DWU's connection of Lake Palestine to Joe Pool Lake
3 (Interconnection)	Integrated System: Interconnected Third Pipeline (upsized as compared to the baseline condition) with connection of Lake Palestine to Cedar Creek Reservoir and delivery to DWU at Joe Pool Lake and TRWD's customers through the Third Pipeline
4 (Interconnection)	Integrated System: Interconnected "Southern Pipeline" - Lake Palestine delivered to the Lake Benbrook pipeline via a pipeline route to the south of the TRWD Third Pipeline route. Delivery to DWU at Joe Pool Lake and TRWD's customers through connections to the existing system and the Lake Benbrook pipeline.

Screening level/conceptual capital cost analyses for each project conveyance alternative are presented below. Background information and the results of the life-cycle cost analysis are then presented along with a discussion of the life-cycle cost analysis method. The reader should refer to section 1.4.2 for a discussion of the uncertainties and limitations associated with the development of this preliminary cost analysis and section 1.4.3 for recommendations for future cost analyses that will help refine the cost information and provide differentiation between Interconnection alternatives.

3.2 Capital Cost Analysis

The conceptual capital cost estimates for each project conveyance alternative are presented in **Table 3-1**. The table also contains the component pieces of the baseline alternatives broken down into individual capital cost estimates. The pipelines that compose these conveyance alternatives are:

TRWD Baseline Third Pipeline

- Cedar Creek to Ennis Pump Station
- Richland-Chambers to Ennis Pump Station
- Ennis Pump Station to Rolling Hills Water Treatment Plant

DWU Baseline

- Lake Palestine to Southeast WTP; or
- Lake Palestine to Joe Pool Lake

Interconnected Third Pipeline

- Lake Palestine to Cedar Creek Reservoir
- Cedar Creek Reservoir to Ennis Pump Station
- Richland-Chambers to Ennis Pump Station
- Ennis Pump Station to Rolling Hills Water Treatment Plant

Interconnected Southern Pipeline

- Lake Palestine to Lake Benbrook (Southern Route)
- Cedar Creek to Southern Pipeline
- Richland-Chambers Reservoir to Southern Pipeline
- Southern Pipeline to Joe Pool Lake Interconnect (interconnect w/TRWD Lines but effectively adjacent to Joe Pool connection)

Table 3-1
Results of Conceptual Capital Cost Analysis

Baseline Alternatives	Capital Cost (2008 basis)
Alternative 1: TRWD Third Pipeline + DWU Lake Palestine to SE WTP	$1,177,844,000
(Component 1: DWU Lake Palestine to SE WTP)	(548,949,000)
(Component 2: TRWD Third Pipeline)	(628,894,000)
Alternative 2: TRWD Third Pipeline + Lake Palestine to Joe Pool Lake	$1,303,360,000
(Component 1: DWU Lake Palestine to Joe Pool Lake)	(674,466,000)
(Component 2: TRWD Third Pipeline)	(628,894,000)
Interconnection Alternatives	
Alternative 3: Interconnected Third Pipeline	$1,083,966,000
Alternative 4: Interconnected Southern Pipeline	$1,355,279,000

3.3 Lifecycle Cost Analysis

Results from the screening level life-cycle cost analyses are shown in **Table 3-2** and **Table 3-3**. **Table 3-2** presents results on a total cost basis over 50 years, a Present Value basis (2008 dollars), and on a unit cost basis (i.e. cost per 1,000 gallons). The comparison of life-cycle costs for each project conveyance alternative is presented in **Table 3-3**.

Each of the primary variables in these lifecycle calculations are described in the sections below **Table 3-4**. These variables were: debt service and the discount rate, renewal and replacement costs, operational (energy) costs, and operations and maintenance.

Unit costs are specifically excluded from these results because only a portion of the DWU and TRWD transmission systems were modeled and because costs and water volumes were not allocated between the two entities in this study (this analysis will be necessary in subsequent phases).

Table 3-2
Lifecycle Cost Analysis Results

Baseline Alternatives	Total Cost (50-year Life)	Present Value Cost
Alternative 1: TRWD Third Pipeline + DWU Lake Palestine to SE WTP	$6,043,044,000	$2,462,651,000
(Component 1: DWU Lake Palestine to SE WTP)	(2,738,178,000)	(1,198,104,000)
(Component 2: TRWD Third Pipeline)	(3,304,866,000)	(1,264,547,000)
Alternative 2: TRWD Third Pipeline + Lake Palestine to Joe Pool Lake	6,774,762,000	$2,776,834,000
(Component 1: DWU Lake Palestine to Joe Pool Lake)	(3,469,896,000)	(1,512,287,000)
(Component 2: TRWD Third Pipeline)	(3,304,866,000)	(1,264,547,000)
Interconnection Alternatives		
Alternative 3: Interconnected Third Pipeline	5,578,924,000	2,238,879,000
Alternative 4: Interconnected Southern Pipeline	6,306,874,000	2,740,189,000

*Note that interconnected alternatives include delivery to Joe Pool Lake, not the SEWTP.

Table 3-3
Lifecycle Cost Differences – Comparison of Project Conveyance Alternatives

Interconnection Alternative	Comparison Baseline Alternative	Total Cost Difference	Present Value Cost Difference
3 (Interconnected Third Pipeline)	1 (w/ Pal. to SE WTP)	$464,120,000	$223,771,000
3 (Interconnected Third Pipeline)	2 (w/ Pal. to Joe Pool)	1,195,837,000	537,954,000
4 (Interconnected Southern Pipeline)	1 (w/ Pal. to SE WTP)	$-263,830,000	$-277,538,000
4 (Interconnected Southern Pipeline)	2 (w/ Pal. to Joe Pool)	467,887,000	36,644,000

*Note that interconnected alternatives include delivery to Joe Pool Lake, not the SEWTP.

3.3.1 Discount Rate

The discount rate is calculated as the cost of debt for the organization that will build the project and is then adjusted as needed to account for elements of risk unique to each project scenario. Because all variables in this life-cycle cost analysis are costs (as opposed to investments), a higher discount rate is favorable; additional risk factors decrease the discount rate as opposed to the traditional increase that would typically occur in an "investment scenario". For the DWU Baseline alternatives, the cost of debt was assumed to be 4.88%, which is equal to the simple average of the interest rates for the series of bonds in the 2006 Waterworks and Sewer System Revenue Refunding and Improvement Bonds from the City of Dallas 2006 Annual Report. For the TRWD Baseline alternative, the cost of debt was assumed to be 5.07%, which is equal to the TRWD 2006 Series Water Revenue Bonds' average annual interest rate. For the Interconnected alternatives, 4.97% was used, which is the simple average of the cost of debt for DWU and TRWD.

With the discount rate set equal to the cost of debt quoted above, risk factors were then identified and quantified in terms of a percentage reduction in the discount rate. The following risk factors were quantified based on the team's expert opinion:

- Political Risk: As a consequence of DWU and TRWD having to coordinate efforts in an interconnected alternative, both of these alternatives were deemed to have some political risk resulting from a potential delay in construction of one year. The cost of this political risk was quantified as 0.20 percent.

- Construction Delay: A reduction in the Interconnected Southern Pipeline alternative discount rate was applied to account for the potential delays associated with real estate acquisition (e.g., easements for pipelines). It was assumed that pipeline construction could begin prior to and concurrent with acquisition of all required easements. This risk was quantified as 0.40 percent to reflect a potential two-year delay in construction. Similarly, a reduction in the DWU Baseline alternatives' discount rate was quantified as 0.30 percent to represent an 18 month delay associated with procuring right-of-way easements. This delay is assumed to be less than the delay for the Interconnected Southern Pipeline alternative because of the relatively shorter pipeline length required for the DWU Baseline alternatives.

The discount rates applied in the 50-year life cycle cost analysis for each component of the project conveyance alternatives are summarized below in **Table 3-4**.

Table 3-4
Discount Rates

Components of Baseline Alternatives	Discount Rate	Interconnection Alternatives	Discount Rate
Lake Palestine to Joe Pool Lake		Interconnected 3rd Pipeline	
Cost of Debt	4.88%	Cost of Debt	4.97%
Cost of Delay	-0.30%	Political Risk	-0.20%
Total	4.58%	Total	4.77%
Lake Palestine to SE WTP			
Cost of Debt	4.88%	Southern Pipeline	
Cost of Delay	-0.30%	Cost of Debt	4.97%
Total	4.58%	Political Risk	-0.20%
TRWD Third Pipeline		Cost of Delay	-0.40%
Cost of Debt	5.07%	Total	4.37%
Total	5.07%		

3.3.2 Renewal and Replacement Costs

Some infrastructure elements will require replacement during the 50-year life-cycle of the system. The renewal and replacement analysis captured this element of cost for each project scenario. An example of renewal and replacement cost assumptions applied to the Interconnected Third Pipeline is shown in the **Table 3-5**.

Table 3-5
Renewal and Replacement: Average Years to Renewal

	Channel Dam / Intake	Pump Stations (Elec/Mech Equipment)	Tanks	Pipelines	Disinfection /Surge Control
Average Years to Renewal	50	30	50	50	25

It was assumed that only the pump stations and disinfection/surge control equipment are likely to require replacement during the 50-year project life-cycle. Estimated equipment life was obtained from the TCEQ System of Accounts, June 1999. It was assumed that 40 percent of the original capital costs will be required to replace certain elements of the pump station facilities and that the remaining 60 percent represents structural components, which have a significantly longer life expectancy. The pump station replacement cost was increased by another 20 percent to act as a contingency for unquantified pump station renewal costs.

For this analysis, the disinfection/surge control equipment was assumed to require 100 percent replacement and an additional 20 percent was added for contingency. The renewal and replacement costs for both pump stations and disinfection/surge control equipment were then inflated by the projected long-term U.S. inflation rate to estimate the capital costs at the time of renewal or replacement.

3.3.3 Energy Costs

Energy costs were calculated as the product of an assumed energy rate and the usage for each project conveyance alternative. The energy usage was based on the system operations model (see Section 2), which calculated operational costs (energy) in kilowatt hours (kWh) over seven years of assumed hydrologic conditions, either drought or normal. For the life-cycle cost analysis, energy usage during normal hydrologic conditions was used to represent average conditions over the 50-year life-cycle.

The energy rate was based on data from the Electric Reliability Council of Texas (ERCOT) for electric power delivered within the ERCOT North Texas Zone; an energy rate of $0.084/kwh was used in this analysis .This rate was not escalated over the course of the 50-year lifecycle of each project based on the US Department of Energy Annual Energy Outlook 2008 Energy Prices by Sector and Source forecast.

3.3.4 Operations and Maintenance Costs

Operations and maintenance (O&M) costs for each project alternative were calculated in accordance with Texas Water Development Board (TWDB) guidelines for regional water supply planning. TWDB guidelines provide an estimated fixed percentage of construction cost for various types of facilities to estimate O&M costs. The construction cost is the capital cost for each facility type and does not include financing or other related costs.

O&M costs were escalated over time using the inflation rate, projected as the long-term U.S. inflation rate according to the U.S. Bureau of Labor Statistics. Its intent was to capture the increase in wages and other costs associated with operations and maintenance. Energy costs were not included in this O&M cost calculation because they were considered independently. An example of the estimated annual O&M costs for the Interconnected Third Pipeline alternative is shown in **Table 3-6**.

Table 3-6
Operations and Maintenance as a Percentage of Construction Cost

	Channel Dam / Intake	Pump Stations	Tanks	Pipelines	Disinfection / Surge Control
O&M as % of Construction Cost	1.50%	2.50%	2.50%	1.00%	2.50%

3.4 Lifecycle Cost Analysis Conclusions

The purpose of the cost analysis task was to develop a screening level/conceptual opinion of probable capital and lifecycle cost for each project conveyance alternative and to conduct a present worth economic comparison between the Baseline and Interconnection alternatives. Results were presented above in **Tables 3-2** and **3-3** and show that there are opportunities for significant cost savings through an integration of the raw water transmission systems to deliver Lake Palestine water to DWU and TRWD.

Delivering water through an Interconnected Third Pipeline has potential Present Value, 50-year life-cycle cost savings between approximately $220,000,000 and $540,000,000.

The Interconnected Southern Pipeline alternative has potential Present Value, 50-year life-cycle cost savings when compared to Alternative 2 (baseline with delivery to Joe Pool) but increased cost when compared to Alternative 1 (baseline with delivery to SE WTP). However, because the Interconnected Southern Pipeline delivers water to Joe Pool Lake and not the SE WTP, the most direct comparison is between the Interconnected Southern Pipeline and Alternative 2, which results in an approximate $36,600,000 savings. Subsequent phases of this feasibility assessment will consider other potential benefits from the Southern Pipeline, such as supply risk reduction and right-of-way acquisition for future supplies. For example, TRWD has recently experienced the following average costs for securing easements for several large diameter transmission system projects:

- Real estate classified as rural - $15,415 per acre.
- Real estate classified as undeveloped, planned - $33,792 per acre.
- Real estate classified as developed - $71,247 per acre.

These costs raise the issue of expedited acquisition of right-of-way (e.g. in the Southern Pipeline route) to manage the availability and cost of acquisition for this and future water supplies. Also, phasing could also result in significant reduction of costs associated with the Interconnected Southern Pipeline due to the potential to defer development of transmission facilities required to deliver water to Lake Benbrook.

Section 4
Constraints Analysis

A preliminary facility siting constraints analysis was performed to identify potential fatal flaws to locating water transmission facilities along select pipeline corridors and to make a comparison between project conveyance alternatives. The data collected for the constraints analysis will also have use during subsequent phases of engineering. The preliminary constraints analysis was accomplished using publicly available data from secondary sources (no field data collection). A database of constraint data and aerial photography was developed using Geographic Information System (GIS) applications software. Using this spatial data, a team of subject matter experts identified potential facility siting constraints in three categories: land use, environmental, and technical (engineering). After relevant data was compiled and analyzed for each potential constraint, subject matter experts rated the potential for impact as "High", "Medium", "Low", or "No Impact" and the team then came to a consensus on the overall potential impact on each transmission corridor.

The facility siting constraints analysis is summarized in the Alternatives Evaluation Matrix (AEM). This tool is simply a tabulation of the constraints within the three impact categories, beginning with the generalized "Impact Category", which is then broken down into "Evaluation Criteria", which are comprised of "Components". Basic facility data is also included in the AEM to identify each alternative and quantify dimensions and capacities of water transmission infrastructure.

This section summarizes the constraints analysis. First is a description of the infrastructure components in each of the four scenarios. Next is a discussion of the Alternatives Evaluation Matrix (AEM). Lastly, preliminary findings and consensus evaluations are presented.

4.1 Description of Alternatives

Like all other project analyses, the constraints analysis compared four project conveyance alternatives, which are listed in **Table 1-1** and reproduced here for the reader's convenience.

Alternative	Description
1 (Baseline)	Independent Systems: TRWD's East Texas Third Pipeline and DWU's connection of Lake Palestine to the proposed Southeast Water Treatment Plant
2 (Baseline)	Independent Systems: TRWD's East Texas Third Pipeline and DWU's connection of Lake Palestine to Joe Pool Lake
3 (Interconnection)	Integrated System: Interconnected Third Pipeline (upsized as compared to the baseline condition) with connection of Lake Palestine to Cedar Creek Reservoir and delivery to DWU at Joe Pool Lake and TRWD's customers through the Third Pipeline
4 (Interconnection)	Integrated System: Interconnected "Southern Pipeline" - Lake Palestine delivered to the Lake Benbrook pipeline via a pipeline route to the south of the TRWD Third Pipeline route. Delivery to DWU at Joe Pool Lake and TRWD's customers through connections to the existing system and the Lake Benbrook pipeline.

A brief description of the facilities used in each alternative, and the basis for their selection, follows. The reader should refer to **Figures 1-4 through 1-8** for mapping of the infrastructure components that make up each of the four project conveyance alternatives.

DWU Baseline – Palestine to Southeast WTP

DWU's primary baseline alternative for connecting Lake Palestine to the DWU service area is to construct a pipeline directly from Lake Palestine to the site of the proposed Southeast Water Treatment Plant (WTP) in Hutchins, TX. This baseline alternative consists of three principal components:

- An intake pump station at Lake Palestine;
- A single 84 inch pipeline from Lake Palestine to the Southeast WTP; and
- A booster pump station at Murchison, TX.

Almost two decades have passed since planning level studies were completed for this project alternative, which at the time included site selection for the Southeast WTP and the intake at Lake Palestine, and an alignment study for the transmission pipeline (see Lake Palestine Utilization and Pipeline Alignment Study, by Dannenbaum Engineering Corporation, June 1989). The recommended pipeline alignment and locations for the intake and WTP were used in this constraints analysis.

According to DWU staff, the Southeast WTP location recommended in the previous study is favorable for interconnection with the DWU distribution system. However, the WTP site is adjacent to two intermodal transportation facilities that will make development of a facility at that site difficult. The location of the WTP could be moved longitudinally along the previously studied pipeline alignment but suitable alternative sites are not readily available.

DWU Baseline – Lake Palestine to Joe Pool Lake

An alternative stand-alone baseline project for DWU is to construct a pipeline from Lake Palestine to Joe Pool Lake. This baseline alternative consists of three principal components:

- An intake pump station at Lake Palestine;
- A single 84 inch pipeline from Lake Palestine to Joe Pool Lake; and
- Two booster pump stations.

This baseline alternative was proposed for evaluation by DWU due to potential limitations to the original proposed site for the Southeast WTP. Delivery of Lake Palestine water to Joe Pool Lake offers potential advantages in terms of development of a new WTP in proximity to portions of the DWU service area where additional supplies are needed. A WTP site near Mountain Creek Lake would provide treatment capacity in close proximity to the high, medium, and low pressure planes of the DWU service area. Alternatively, Lake Palestine water supplies could be transferred from Joe Pool Lake to the existing DWU Bachman WTP (see Section 8 of this report), thereby freeing up raw water supplies from Lake Lewisville and Lake Ray Roberts for expansion of the DWU Elm Fork WTP.

Because the corridor between the Southeast WTP site and Joe Pool Lake is largely urbanized, the pipeline alignment for this baseline alternative would not follow the same route proposed for delivery to the Southeast WTP. Instead, it would follow a more southerly route from Lake Palestine to Joe Pool Lake, passing between the Richland-Chambers and Cedar Creek Reservoirs.

TRWD Baseline – Third Pipeline

TRWD's baseline alternative is to construct additional conveyance capacity to deliver water from Richland-Chambers Reservoir and Cedar Creek Lake to as far west as Rolling Hills WTP and intermediate delivery points. This "East Texas Third Pipeline" would share existing right-of-way with two existing TRWD pipelines. TRWD's baseline alternative consists of six principal components:

- Additional intake capacity at Richland-Chambers Reservoir and a 60 inch pipeline to the existing TRWD Ennis Booster Pump Station;
- Additional intake capacity at Cedar Creek Lake and a 72 inch pipeline to the Ennis Booster Pump Station;
- A single 84 inch pipeline to carry the combined additional flow from the Ennis Booster Pump Station to existing TRWD balancing reservoirs at Kennedale;
- A bi-directional 96 inch pipeline from the Kennedale balancing reservoirs to the Rolling Hills WTP;

- Additional pumping capacity at the existing TRWD pump stations at Ennis and Waxahachie; and

Because of the potential to share existing pipeline right-of-way and booster pump station infrastructure, the Third Pipeline is thought to be the lowest cost baseline alternative for TRWD to deliver additional raw water from its East Texas reservoirs

Interconnected Third Pipeline

This alternative would deliver raw water supplies from Lake Palestine through an interconnected system to both TRWD and DWU. This alternative includes the same principal components as the above TRWD baseline alternative, up-sized for the additional flow from Lake Palestine, and the following additional components:

- An intake pump station at Lake Palestine;
- A single 72 inch pipeline from Lake Palestine to Cedar Creek Reservoir; and
- A turnout from the Third Pipeline to deliver water to Joe Pool Lake.

Interconnected Southern Pipeline

This project conveyance alternative was considered as an option to the Interconnected Third Pipeline because of the potential benefits to system reliability (three pipelines in one shared transmission corridor may increase the risk of failure for all three lines and therefore lower the reliability of the East Texas supply), right-of-way acquisition, and phasing. This alternative would provide an alignment and reserve right-of-way for the transmission of future water supplies from East Texas and consists of the following principal components:

- An intake pump station at Lake Palestine;
- A single 108 inch pipeline from Lake Palestine to Benbrook Lake;
- A bi-directional 66 inch interconnection pipeline from Richland-Chambers Reservoir;
- A bi-directional 72 inch interconnection pipeline from Cedar Creek Lake;
- A 108 inch interconnection pipeline to Joe Pool Lake;
- Three booster pump stations.

The Interconnected Southern Pipeline would pass between Richland-Chambers and Cedar Creek Reservoirs. Interconnections with both reservoirs would provide flexibility to deliver Lake Palestine water into these reservoirs for temporary storage or to add supply from these lakes to the joint transmission line. These interconnects would increase operational flexibility and yield reliability.

Pipeline Corridors

At this stage of the Lake Palestine Project Viability Assessment, pipeline alignments were defined broadly, in spatial terms. The constraints analysis was performed on a two-mile wide corridor for each pipeline segment around an assumed centerline. Constraints data was analyzed to indicate the potential for utility, environmental, and other conflicts within each corridor rather than along the assumed centerline. The assumed centerline was defined by the project team by first assuming the shortest route between the beginning and end points, and then deviating from that line in consideration of apparent conflicts (e.g., towns, major water courses, road crossings, etc.). **Figure 4-1** shows an approximate centerline longitudinal surface elevation profile for some of the primary alternative routes.

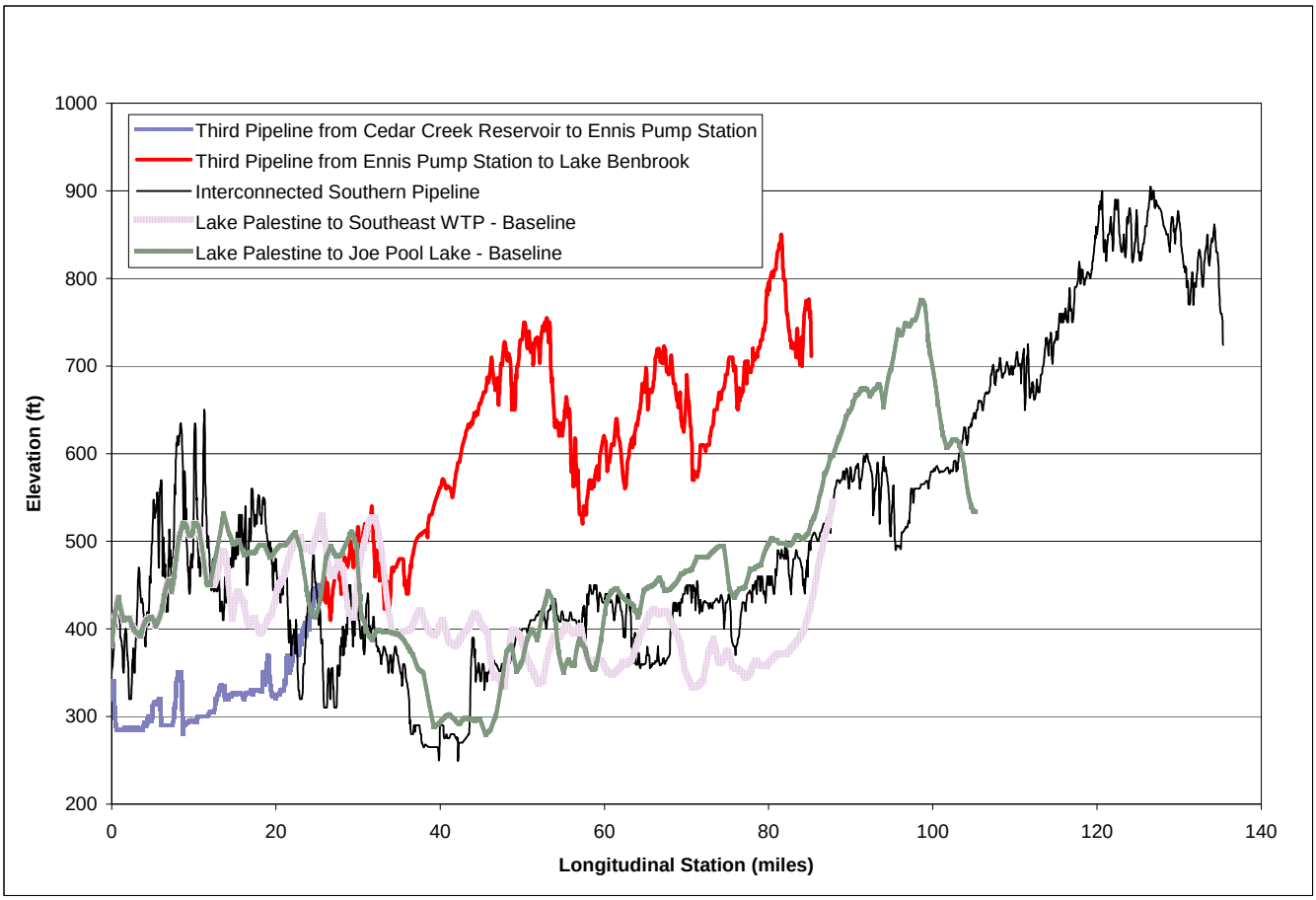


Figure 4-1
Approximate Pipeline Longitudinal Surface Elevation Profiles

4.2 Alternatives Evaluation Matrix

An Alternatives Evaluation Matrix (AEM) was developed to evaluate the occurrence and level of constraints for each pipeline in the project scenarios. This tool is simply a tabulation of the constraints within three classifications, beginning with the generalized "Impact Category", which is then subdivided into "Evaluation Criteria", which are further subdivided into "Components".

1. Impact Categories – Basic Data (not constraints, but necessary to the evaluation), Land Use, Environmental, and Technical (Engineering)

2. Evaluation Criteria – This subset of the impact categories represents the place at which ratings were assigned to the potential impact of constraints on a project alternative. For example, in the environmental impact category, the wetlands criteria may be rated as a High, Medium, Low, or None based on the data analyzed for each component.

3. Components – Each criterion is composed of several components, or attributes data, that become the basis for rating the potential impact. To continue with the previous example, the wetlands criteria components include forested wetlands, non-forested, waters of the U.S., etc.

The impact categories and evaluation criteria selected for the AEM are listed in **Table 4-1**.

To support the constraints analysis process, data were collected from reliable sources and stored in an ArcGIS 9 environment using a common spatial projection. A series of constraint maps were then designed so that the team could visualize potential constraints and their interrelationship. A list of the data and sources used for this analysis is shown in **Table 4-2**.

The final products of the constraints analysis were: 1) a collection of data needed for future phases of engineering, such as conceptual and preliminary design; and 2) a qualitative rating of the potential impact on each evaluation criteria and a consensus evaluation of the overall potential impact of the identified constraints on each project conveyance alternative. Subject matter experts provided an opinion based on the constraints data and rated the evaluation criteria. After each component was quantified and the evaluation criteria were rated, the evaluation team reached consensus on the overall potential impact rating for each scenario.

Table 4-1
Constraint Evaluation Criteria

Impact Category	Category ID No.	Evaluation Criteria
Basic Data	B.1	Intake Facilities; Intake pump station
	B.2	Transmission Facilities Pipelines and Booster PS
Land Use	L.1	Residences
	L.2	Commercial Businesses
	L.3	Schools
	L.4	Parks and Recreation Areas
	L.5	Oil & Gas
	L.6	Other Wells
	L.7	Hazardous Material Sites
	L.8	Airports
	L.9	Mines
	L.10	Existing Roads, Highways and Railroads
	L.11	Agriculture & Non-Tillable Land Based on Soil Type
	L.12	Land Use
Environmental	E.1	Vegetation
	E.2	Conservation
	E.3	Noise
	E.4	Wetlands/Water of the US
	E.5	Wildlife Habitats
	E.6	Cultural Resources
	E.7	Visual
Technical (Engineering)	T.1	Drainage and Hydrologic
	T.2	Electric Transmission Lines
	T.3	Topography
	T.4	Proximity to Infrastructure
	T.5	Site Conditions

Table 4-2
List of Source and Data Used in Constraint Analysis

Source	Base Map Data
National Hydrography Dataset/EPA	Streams
	Waterbodies
Texas Natural Resource Information System	Contours
	USGS Topographic Map Grid
Texas Railroad Commission	Abstracts
US Census Bureau	Cities
	Parks
	Streets
Source	**Constraint Data**
ERCOT	Electrical Transmission
Texas Commission on Environmental Quality	Impaired Streams
	Impaired Water Bodies
	Permitted Industrial Hazardous Waste Sites
	Radioactive Waste Sites
	Superfund Cleanup Sites
	Surface Water Rights
	Wastewater Outfalls
Texas Education Agency	School Districts
	Schools
Texas Historical Commission	Historical Markers
Texas Historical Commission and USGS	Cemeteries
Texas Parks and Wildlife	State Parks
	Threatened and Endangered Species
	Vegetation Type
Texas Railroad Commission	Oil and Gas Pipelines
	Oil and Gas Wells
Texas Water Development Board	Groundwater Wells
United States Department of Agriculture	Soils/Farm Lands
US Census Bureau	Airports
USGS	Land Use
USGS/National Atlas	Agricultural Mine
	Crushed Stone Mines
	Federal Lands
	National Parks
	Sand/Gravel Mines

4.3 Preliminary Findings and Consensus Evaluations

The preliminary findings of the constraints analysis are contained in the Alternatives Evaluation Matrix (AEM), with an analysis of each evaluation criterion and component, and an impact rating for each evaluation criterion. Using the ratings from each impact category and the opinions of the subject matter experts, a consensus evaluation was reached for each project conveyance alternative. The consensus evaluation is summarized in **Table 4-3**, **Table 4-4** and **Table 4-5.**

The evaluation team agreed that, based on the available data, no fatal flaws were detected in this analysis and each of the pipeline corridors are potentially viable and can be recommended for further analysis.

The consensus evaluations in **Table 4-3**, **Table 4-4** and **Table 4-5** also show that, based on the available data, there are no significant differentiators between project alternatives in terms of land use, environmental, or technical (engineering) constraints. Differentiation in terms of lifecycle cost, reliability, operations and maintenance, water quality, and other factors is addressed in other sections of this report. Subsequent phases of project definition and development will provide the quantitative data needed to differentiate the occurrence and significance of constraints within each alternative pipeline corridor

Table 4-3
Baseline Alternatives Constraints Analysis Consensus Evaluations

Impact Category	Category ID No.	Evaluation Criteria	Baseline				
			DWU 2	DWU 1	TRWD		
			Palestine to JP	Palestine to SE WTP	CC to Ennis	RC to Ennis	Ennis to RHWTP
Basic Data	B.1	Intake Facilities; Intake pump station	--	--	--	--	--
	B.2	Transmission Facilities Pipelines and Booster PS	--	--	--	--	--
Land Use	L.1	Residences	Low	Low	Low	Low	Low
	L.2	Commercial Businesses	Low	Low	Low	Low	Low
	L.3	Schools	None	None	None	None	None
	L.4	Parks and Recreation Areas	None	Low	None	None	Low
	L.5	Oil & Gas	Med	Low	Low	Med	High
	L.6	Other Wells	Low	Low	Low	Low	Low
	L.7	Hazardous Material Sites	Low	Low	Low	Low	Low
	L.8	Airports	Low	Low	Low	Low	Low
	L.9	Mines	Low	Low	Low	Low	Low
	L.10	Existing Roads, Highways and Railroads	Med	Med	Low	Med	High
	L.11	Agriculture & Non-Tillable Land Based on Soil Type	Low	Low	Low	Low	Low
	L.12	Land Use	Med	Med	Low	Low	Med
Environ-mental	E.1	Vegetation	Med	Med	Low	Low	Med
	E.2	Conservation	None	None	None	None	None
	E.3	Noise	Low	Low	Low	Low	Low
	E.4	Wetlands/Water of the US	Med	Med	Low	Med	Med
	E.5	Wildlife Habitats	Med	Med	Med	Med	Med
	E.6	Cultural Resources	Med	Med	Low	Low	Med
	E.7	Visual	Low	Low	Low	Low	Low
Technical (Engin-eering)	T.1	Drainage and Hydrologic	Med	Med	Low	Low	Low
	T.2	Electric Transmission Lines	Med	Low	Low	Low	High
	T.3	Topography	Low	Low	Low	Low	Low
	T.4	Proximity to Infrastructure	Low	Low	Low	Low	Low
	T.5	Site Conditions	Med	High	Med	low	Low
Consensus Evaluation of Constraint Level			Med	Med	Low	Low	Med

Table 4-4
Interconnected Third Pipeline Alternative Constraints Analysis Consensus Evaluations

Impact Category	Category ID No.	Evaluation Criteria	Interconnected Third Pipeline			
			Pal to CC	CC to Ennis PS	RC to Ennis	Ennis to RHWTP
Basic Data	B.1	Intake Facilities; Intake pump station	--	--	--	--
	B.2	Transmission Facilities Pipelines and Booster PS	--	--	--	--
Land Use	L.1	Residences	Low	Low	Low	Med
	L.2	Commercial Businesses	Low	Low	Low	Low
	L.3	Schools	None	None	None	None
	L.4	Parks and Recreation Areas	None	None	None	None
	L.5	Oil & Gas	Med	Low	Med	High
	L.6	Other Wells	Low	Low	Low	Low
	L.7	Hazardous Material Sites	Low	Low	Low	Low
	L.8	Airports	Low	Low	Low	Low
	L.9	Mines	Low	Low	Low	Low
	L.10	Existing Roads, Highways and Railroads	Med	Low	Med	High
	L.11	Agriculture & Non-Tillable Land Based on Soil Type	Low	Low	Low	Low
	L.12	Land Use	Low	Low	Low	Med
Environ-mental	E.1	Vegetation	Low	Low	Low	Med
	E.2	Conservation	Low	None	None	None
	E.3	Noise	Low	Low	Low	Low
	E.4	Wetlands/Water of the US	Med	Low	Med	Med
	E.5	Wildlife Habitats	Med	Med	Med	Med
	E.6	Cultural Resources	Low	Low	Low	Med
	E.7	Visual	Low	Low	Low	Low
Technical (Engin-eering)	T.1	Drainage and Hydrologic	Med	Low	Low	Low
	T.2	Electric Transmission Lines	Low	Low	Low	High
	T.3	Topography	Low	Low	Low	Low
	T.4	Proximity to Infrastructure	Low	Low	Low	Low
	T.5	Site Conditions	High	Med	Low	Low
Consensus Evaluation of Constraint Level			Med	Low	Low	Med

Table 4-5
Interconnected Southern Pipeline Alternative Constraints Analysis Consensus Evaluations

Impact Category	Category ID No.	Evaluation Criteria	Interconnected Southern Pipeline			
			Pal to Benbrook	CC to Southern Rte	RC to Southern Rte	So Rte to JP (intcnct)
Basic Data	B.1	Intake Facilities; Intake pump station	--	--	--	--
	B.2	Transmission Facilities Pipelines and Booster PS	--	--	--	--
Land Use	L.1	Residences	Low	Low	Low	Low
	L.2	Commercial Businesses	Low	Low	Low	Low
	L.3	Schools	None	None	None	None
	L.4	Parks and Recreation Areas	None	None	None	None
	L.5	Oil & Gas	High	Low	High	High
	L.6	Other Wells	Low	Low	Low	Low
	L.7	Hazardous Material Sites	Low	Low	Low	Low
	L.8	Airports	Low	Low	Low	Low
	L.9	Mines	Low	Low	Low	Low
	L.10	Existing Roads, Highways and Railroads	High	Med	High	Med
	L.11	Agriculture & Non-Tillable Land Based on Soil Type	Low	Low	Low	Low
	L.12	Land Use	Low	Low	Low	Low
Environ-mental	E.1	Vegetation	Med	Low	Low	Low
	E.2	Conservation	None	None	None	None
	E.3	Noise	Low	Low	Low	Low
	E.4	Wetlands/Water of the US	Med	Low	Low	Med
	E.5	Wildlife Habitats	Med	Med	Med	Low
	E.6	Cultural Resources	Low	Low	Low	Low
	E.7	Visual	Low	Low	Low	Low
Technical (Engin-eering)	T.1	Drainage and Hydrologic	Med	Low	Med	Med
	T.2	Electric Transmission Lines	Med	Med	Med	High
	T.3	Topography	Low	Low	Low	Low
	T.4	Proximity to Infrastructure	Low	Low	Low	Low
	T.5	Site Conditions	Med	Med	Low	Low
Consensus Evaluation of Constraint Level			Med	Low	Med	Med

Section 5
Environmental Water Quality

The purpose of the environmental water quality review was to assess receiving water quality impacts due to the introduction of Lake Palestine water under varying conditions into Lake Benbrook, Cedar Creek Reservoir, Richland-Chambers Reservoir, and Joe Pool Lake. The water quality review included data collection and analysis, mass balance calculations, and a water quality evaluation.

5.1 Data Collection and Analyses

Multiple sources, including the United States Army Corps of Engineers (USACE), TRWD, Trinity River Authority (TRA), Upper Neches River Municipal Water Authority, and the Texas Commission on Environmental Quality (TCEQ), were used to obtain daily historical reservoir storage and water quality data for this study. Reservoir volume data were analyzed for the following time periods in each of these reservoirs:

- Lake Benbrook: January 1980 - December 2007
- Cedar Creek Reservoir: January 1980 - December 2007
- Richland-Chambers Reservoir: January 1989 - December 2007
- Joe Pool Lake: January 1990 - September 2007.

Water quality data were collected and evaluated for each reservoir from January 1997 through December 2006 for alkalinity, dissolved iron, dissolved manganese, hardness, total dissolved solids, total organic carbon, pH, chlorophyll-A, dissolved oxygen, nitrite + nitrate, orthophosphate phosphorus, total phosphorus, secchi depth, and temperature.

Water quality data from TRWD's field-scale wetland system was collected and analyzed from June 2003 through March 2007. Because not all of the water quality parameters analyzed in the study reservoirs were available from TRWD's field-scale wetland system, this evaluation was limited to the following parameters: alkalinity, hardness, nitrite + nitrate, orthophosphate phosphorus, and total phosphorus.

For comparison purposes, the 2006 Region C Water Plan included an assessment of 5 key surface water quality parameters (ammonia nitrogen, nitrate nitrogen, total phosphorus, chlorophyll-a, and total dissolved solids) in its evaluation of water quality impacts for the recommended water management strategies based upon historical median concentrations of the parameters in the source and receiving waters.

5.2 Environmental Water Quality Mass Balance

As part of this water quality assessment, a water quality mass balance was performed to analyze the impact on water quality due to introducing Lake Palestine water into Lake Benbrook, Cedar Creek Reservoir, Richland-Chambers Reservoir, and/or Joe Pool Lake. The water quality parameters evaluated utilizing a mass balance approach include:

- Alkalinity
- Dissolved Iron
- Dissolved Manganese
- Hardness
- Total Dissolved Solids
- Total Organic Carbon
- Chlorophyll-A
- Dissolved Oxygen
- Nitrite + Nitrate
- Orthophosphate Phosphorus
- Total Phosphorus.

The mass balance calculation utilized the historical water quality conditions shown in **Table 5-1** with the introduction of 102 MGD of water from Lake Palestine over a 3 and 6 month period. Lake Palestine water was added to the receiving reservoir as a volume with a specified concentration. The volume of Lake Palestine water was calculated by multiplying 102 MGD by 90 days for the 3 month mass balance and by 180 days for the 6 month mass balance. Lake Palestine water was introduced under various reservoir volume conditions for Lake Benbrook, Cedar Creek Reservoir, Richland- Chambers Reservoir, and Joe Pool Lake. The destination reservoirs were evaluated at reservoir volume conditions equal to the 50th, 75th, and 90th percentile of historical volume and at 50%, 75%, and 90% of the conservation storage capacity. **Table 5-2**, through **Table 5-5** present the results of the calculated water quality concentrations of each parameter after the introduction of Lake Palestine water.

When available, water quality data from the main body of the reservoirs was utilized. Water quality data from TRWD's field-scale wetland system into Alligator Creek was also utilized for this analysis. Average water quality parameter concentrations were calculated for 3 and 6 month time periods from January 1997 through December 2006 for the reservoirs and from June 2003 through March 2007 for the wetland system. The 3 month averages include the months of July through September and the 6 month averages include the months of June through November. For each parameter in the reservoirs, the 3 and 6 month averages were developed by first averaging the concentrations of samples taken at different depths at the same location at the same time. Then, the concentrations for samples taken on the same date in the main pool of the reservoir were averaged to obtain an overall concentration for the reservoir on each sample date. Finally, the concentrations for dates that fell within the 3 and 6 month time period were averaged to acquire one concentration for each time period that would represent the overall average concentration in the main pool of the reservoir. The Alligator Creek data did not have multiple sampling locations, depths, or multiple samples per day; therefore, the wetland system data was simply averaged in 3 and 6 month time periods.

Table 5-1
Average Background Concentrations for Treatability and Nutrient Parameters

	Parameter	Time Period	Benbrook	Cedar Creek	Richland-Chambers	TRWD Wetland	Joe Pool	Palestine
Treatability Parameters	Alkalinity (mg/L)	3 Month	96.67	59.59	86.25	121.26	102.69	37.50
		6 Month	106.81	61.82	90.51	113.02	106.04	37.85
	Dissolved Iron (ug/L)	3 Month	22.78	26.14	33.91	---	67.74	110.00
		6 Month	22.58	78.73	40.53	---	59.02	110.00
	Dissolved Manganese (ug/L)	3 Month	28.17	132.43	35.64	---	103.77	250.00
		6 Month	24.73	82.61	30.62	---	90.48	250.00
	Hardness (mg/L)	3 Month	140.00	50.00	95.00	171.96	149.38	40.00
		6 Month	140.00	50.00	95.00	167.41	153.17	47.67
	Total Dissolved Solids (mg/L)	3 Month	181.47	130.46	153.48	---	318.88	138.60
		6 Month	189.17	131.71	159.36	---	312.55	138.41
	Total Organic Carbon (mg/L)	3 Month	5.18	6.94	5.39	---	4.05	8.63
		6 Month	5.25	6.91	5.41	---	4.76	8.50
	pH	3 Month	7.98	8.20	8.10	---	8.08	7.65
		6 Month	7.96	8.10	8.07	---	8.13	7.55
Nutrient Parameters	Chlorophyll-A (ug/L)	3 Month	31.57	34.07	21.10	---	6.85	42.83
		6 Month	26.63	30.21	20.98	---	6.85	39.39
	Dissolved Oxygen (mg/L)	3 Month	5.62	5.56	4.85	---	6.39	5.26
		6 Month	5.96	6.21	5.48	---	7.22	5.51
	Nitrite + Nitrate (mg/L)	3 Month	0.01	0.03	0.03	0.11	0.06	0.38
		6 Month	0.02	0.07	0.06	0.20	0.08	0.42
	Orthophosphate Phosphorus (mg/L)	3 Month	0.01	0.04	0.02	0.82	0.02	0.06
		6 Month	0.01	0.03	0.01	0.60	0.02	0.06
	Total Phosphorus (mg/L)	3 Month	0.08	0.11	0.08	0.81	0.03	0.08
		6 Month	0.07	0.10	0.08	0.61	0.06	0.10
	Secchi Depth (m)	3 Month	0.73	0.76	0.93	---	1.07	0.82
		6 Month	0.81	0.78	0.88	---	1.03	0.77
	Temperature (^{o}C)	3 Month	26.73	28.63	27.80	---	28.73	28.20
		6 Month	25.35	26.72	26.11	---	26.29	26.04

Table 5-2
Water Quality Concentrations in Lake Benbrook with the Inclusion of 102 MGD of Lake Palestine Water

					Benbrook Historical Volume by Percentile (acre-feet)			Benbrook Volume by Percentage of Conservation Storage (acre-feet)		
					50th	75th	90th	50%	75%	90%
					81,960	86,240	89,402	42,824	64,236	77,083
		Background Concentrations			Benbrook Parameter Concentrations after Blending 102 MGD of Lake Palestine Water					
	Parameter	Time Period	Benbrook	Palestine						
Treatability Parameters	Alkalinity (mg/L)	3 Month	96.67	37.50	81.29	81.86	82.26	72.88	78.36	80.58
		6 Month	106.81	37.85	78.44	79.29	79.88	67.35	74.30	77.41
	Dissolved Iron (ug/L)	3 Month	22.78	110.00	45.46	44.61	44.03	57.85	49.78	46.50
		6 Month	22.58	110.00	58.55	57.47	56.72	72.61	63.79	59.85
	Dissolved Manganese (ug/L)	3 Month	28.17	250.00	85.85	83.70	82.21	117.36	96.83	88.50
		6 Month	24.73	250.00	117.40	114.64	112.70	153.63	130.92	120.77
	Hardness (mg/L)	3 Month	140.00	40.00	114.00	114.97	115.64	99.79	109.05	112.80
		6 Month	140.00	47.67	102.01	103.15	103.94	87.16	96.47	100.64
	Total Dissolved Solids (mg/L)	3 Month	181.47	138.60	170.33	170.74	171.03	164.24	168.20	169.81
		6 Month	189.17	138.41	168.29	168.91	169.35	160.13	165.24	167.53
	Total Organic Carbon (mg/L)	3 Month	5.18	8.63	6.08	6.04	6.02	6.57	6.25	6.12
		6 Month	5.25	8.50	6.59	6.55	6.52	7.11	6.78	6.64
	pH	3 Month	7.98	7.65						
		6 Month	7.96	7.55						
Nutrient Parameters	Chlorophyll-A (ug/L)	3 Month	31.57	42.83	34.50	34.39	34.31	36.10	35.05	34.63
		6 Month	26.63	39.39	31.88	31.72	31.61	33.93	32.64	32.07
	Dissolved Oxygen (mg/L)	3 Month	5.62	5.26	5.53	5.53	5.54	5.48	5.51	5.53
		6 Month	5.96	5.51	5.78	5.78	5.78	5.70	5.75	5.77
	Nitrite + Nitrate (mg/L)	3 Month	0.01	0.38	0.11	0.11	0.10	0.16	0.13	0.11
		6 Month	0.02	0.42	0.19	0.18	0.18	0.25	0.21	0.19
	Orthophosphate Phosphorus (mg/L)	3 Month	0.01	0.06	0.02	0.02	0.02	0.03	0.02	0.02
		6 Month	0.01	0.06	0.03	0.03	0.03	0.04	0.03	0.03
	Total Phosphorus (mg/L)	3 Month	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
		6 Month	0.07	0.10	0.08	0.08	0.08	0.09	0.09	0.09
	Secchi Depth (m)	3 Month	0.73	0.82						
		6 Month	0.81	0.77						
	Temperature (°C)	3 Month	26.73	28.20						
		6 Month	25.35	26.04						

Table 5-3
Water Quality Concentrations in Cedar Creek Reservoir with the Inclusion of 102 MGD of Lake Palestine Water

					Cedar Creek Historical Volume by Percentile (acre-feet)			Cedar Creek Volume by Percentage of Conservation Storage (acre-feet)		
					50th	75th	90th	50%	75%	90%
					619,743	636,241	639,596	322,393	483,589	580,307
	Parameter	Background Concentrations			Cedar Creek Parameter Concentrations after Blending 102 MGD of Lake Palestine Water					
		Time Period	Cedar Creek	Palestine						
Treatability Parameters	Alkalinity (mg/L)	3 Month	59.59	37.50	58.60	58.63	58.63	57.77	58.34	58.54
		6 Month	61.82	37.85	59.80	59.84	59.85	58.21	59.29	59.67
	Dissolved Iron (ug/L)	3 Month	26.14	110.00	29.87	29.77	29.76	33.02	30.86	30.11
		6 Month	78.73	110.00	81.37	81.31	81.30	83.45	82.04	81.54
	Dissolved Manganese (ug/L)	3 Month	132.43	250.00	137.65	137.52	137.50	142.07	139.04	137.99
		6 Month	82.61	250.00	96.77	96.44	96.37	107.86	100.34	97.65
	Hardness (mg/L)	3 Month	50.00	40.00	49.56	49.57	49.57	49.18	49.44	49.53
		6 Month	50.00	47.67	49.80	49.81	49.81	49.65	49.75	49.79
	Total Dissolved Solids (mg/L)	3 Month	130.46	138.60	130.82	130.81	130.81	131.13	130.92	130.85
		6 Month	131.71	138.41	132.28	132.26	132.26	132.72	132.42	132.31
	Total Organic Carbon (mg/L)	3 Month	6.94	8.63	7.02	7.01	7.01	7.08	7.04	7.02
		6 Month	6.91	8.50	7.05	7.04	7.04	7.15	7.08	7.05
	pH	3 Month	8.20	7.65						
		6 Month	8.10	7.55						
Nutrient Parameters	Chlorophyll-A (ug/L)	3 Month	34.07	42.83	34.46	34.45	34.45	34.79	34.56	34.48
		6 Month	30.21	39.39	30.98	30.97	30.96	31.59	31.18	31.03
	Dissolved Oxygen (mg/L)	3 Month	5.56	5.26	5.55	5.55	5.55	5.54	5.55	5.55
		6 Month	6.21	5.51	6.15	6.15	6.15	6.11	6.14	6.15
	Nitrite + Nitrate (mg/L)	3 Month	0.03	0.38	0.05	0.05	0.05	0.06	0.05	0.05
		6 Month	0.07	0.42	0.10	0.10	0.10	0.12	0.11	0.10
	Orthophosphate Phosphorus (mg/L)	3 Month	0.04	0.06	0.04	0.04	0.04	0.04	0.04	0.04
		6 Month	0.03	0.06	0.04	0.04	0.04	0.04	0.04	0.04
	Total Phosphorus (mg/L)	3 Month	0.11	0.08	0.11	0.11	0.11	0.11	0.11	0.11
		6 Month	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
	Secchi Depth (m)	3 Month	0.76	0.82						
		6 Month	0.78	0.77						
	Temperature (°C)	3 Month	28.63	28.20						
		6 Month	26.72	26.04						

Table 5-4
Water Quality Concentrations in Richland-Chambers Reservoir with the Inclusion of 102 MGD of Lake Palestine Water

					Richland-Chambers Historical Volume by Percentile (acre-feet)			Richland-Chambers Volume by Percentage of Conservation Storage (acre-feet)		
					50th	75th	90th	50%	75%	90%
					1,110,070	1,138,876	1,154,625	568,300	852,450	1,022,940
	Parameter	Background Concentrations			Richland-Chambers Parameter Concentrations after Blending 102 MGD of Lake Palestine Water					
		Time Period	Richland - Chambers	Palestine						
Treatability Parameters	Alkalinity (mg/L)	3 Month	86.25	37.50	85.02	85.05	85.07	83.90	84.66	84.92
		6 Month	90.51	37.85	87.92	87.99	88.02	85.69	87.19	87.71
	Dissolved Iron (ug/L)	3 Month	33.91	110.00	35.84	35.79	35.76	37.58	36.40	36.00
		6 Month	40.53	110.00	43.94	43.85	43.81	46.89	44.90	44.21
	Dissolved Manganese (ug/L)	3 Month	35.64	250.00	41.06	40.93	40.86	45.98	42.65	41.51
		6 Month	30.62	250.00	41.38	41.12	40.99	50.71	44.43	42.25
	Hardness (mg/L)	3 Month	95.00	40.00	93.61	93.64	93.66	92.35	93.20	93.49
		6 Month	95.00	47.67	92.68	92.73	92.76	90.67	92.02	92.49
	Total Dissolved Solids (mg/L)	3 Month	153.48	138.60	153.11	153.12	153.12	152.77	153.00	153.08
		6 Month	159.36	138.41	158.33	158.36	158.37	157.44	158.04	158.25
	Total Organic Carbon (mg/L)	3 Month	5.39	8.63	5.48	5.47	5.47	5.55	5.50	5.48
		6 Month	5.41	8.50	5.57	5.56	5.56	5.70	5.61	5.58
	pH	3 Month	8.10	7.65						
		6 Month	8.07	7.55						
Nutrient Parameters	Chlorophyll-A (ug/L)	3 Month	21.10	42.83	21.65	21.64	21.63	22.15	21.81	21.69
		6 Month	20.98	39.39	21.89	21.86	21.85	22.67	22.14	21.96
	Dissolved Oxygen (mg/L)	3 Month	4.85	5.26	4.86	4.86	4.86	4.87	4.86	4.86
		6 Month	5.48	5.51	5.48	5.48	5.48	5.48	5.48	5.48
	Nitrite + Nitrate (mg/L)	3 Month	0.03	0.38	0.03	0.03	0.03	0.04	0.04	0.04
		6 Month	0.06	0.42	0.07	0.07	0.07	0.09	0.08	0.08
	Orthophosphate Phosphorus (mg/L)	3 Month	0.02	0.06	0.02	0.02	0.02	0.02	0.02	0.02
		6 Month	0.01	0.06	0.02	0.02	0.02	0.02	0.02	0.02
	Total Phosphorus (mg/L)	3 Month	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
		6 Month	0.08	0.10	0.08	0.08	0.08	0.08	0.08	0.08
	Secchi Depth (m)	3 Month	0.93	0.82						
		6 Month	0.88	0.77						
	Temperature (°C)	3 Month	27.80	28.20						
		6 Month	26.11	26.04						

Table 5-5
Water Quality Concentrations in Joe Pool Lake with the Inclusion of 102 MGD of Lake Palestine Water

					Joe Pool Historical Volume by Percentile (acre-feet)			Joe Pool Volume by Percentage of Conservation Storage (acre-feet)		
					50th	75th	90th	50%	75%	90%
					176,074	178,844	184,316	88,448	132,671	159,206
		Background Concentrations			Joe Pool Parameter Concentrations after Blending 102 MGD of Lake Palestine Water					
	Parameter	Time Period	Joe Pool	Palestine						
Treatability Parameters	Alkalinity (mg/L)	3 Month	102.69	37.50	93.53	93.65	93.88	86.68	91.07	92.71
		6 Month	106.04	37.85	89.30	89.50	89.87	79.24	85.48	88.00
	Dissolved Iron (ug/L)	3 Month	67.74	110.00	73.68	73.60	73.45	78.12	75.28	74.22
		6 Month	59.02	110.00	71.54	71.39	71.11	79.06	74.40	72.51
	Dissolved Manganese (ug/L)	3 Month	103.77	250.00	124.32	124.05	123.53	139.68	129.85	126.17
		6 Month	90.48	250.00	129.64	129.18	128.30	153.18	138.59	132.69
	Hardness (mg/L)	3 Month	149.38	40.00	134.00	134.21	134.60	122.51	129.87	132.62
		6 Month	153.17	47.67	127.27	127.57	128.15	111.70	121.35	125.25
	Total Dissolved Solids (mg/L)	3 Month	318.88	138.60	293.54	293.87	294.52	274.60	286.72	291.26
		6 Month	312.55	138.41	269.80	270.30	271.26	244.10	260.04	266.47
	Total Organic Carbon (mg/L)	3 Month	4.05	8.63	4.69	4.69	4.67	5.18	4.87	4.75
		6 Month	4.76	8.50	5.68	5.67	5.65	6.23	5.89	5.75
	pH	3 Month	8.08	7.65						
		6 Month	8.13	7.55						
Nutrient Parameters	Chlorophyll-A (ug/L)	3 Month	6.85	42.83	11.91	11.84	11.71	15.69	13.27	12.36
		6 Month	6.85	39.39	14.84	14.75	14.57	19.64	16.66	15.46
	Dissolved Oxygen (mg/L)	3 Month	6.39	5.26	6.23	6.23	6.23	6.11	6.19	6.21
		6 Month	7.22	5.51	6.80	6.80	6.81	6.55	6.70	6.77
	Nitrite + Nitrate (mg/L)	3 Month	0.06	0.38	0.10	0.10	0.10	0.14	0.12	0.11
		6 Month	0.08	0.42	0.16	0.16	0.16	0.21	0.18	0.17
	Orthophosphate Phosphorus (mg/L)	3 Month	0.02	0.06	0.02	0.02	0.02	0.03	0.02	0.02
		6 Month	0.02	0.06	0.03	0.03	0.03	0.03	0.03	0.03
	Total Phosphorus (mg/L)	3 Month	0.03	0.08	0.04	0.04	0.04	0.04	0.04	0.04
		6 Month	0.06	0.10	0.07	0.07	0.07	0.08	0.07	0.07
	Secchi Depth (m)	3 Month	1.07	0.82						
		6 Month	1.03	0.77						
	Temperature (°C)	3 Month	28.73	28.20						

Because water quality data were not available for the field-scale wetland system for all of the parameters included in this analysis, **Table 5-3** and **Table 5-4** do not include the addition of the future Cedar Creek and Richland-Chambers constructed wetland systems. A separate analysis of only the parameters available in the wetlands data was performed to show the addition of the wetland systems and the results are shown in **Table 5-6** and **Table 5-7**. Under CA 08-4976C, TRWD may divert 88,059 ac-ft/yr at a maximum rate of 156.6 cfs from the Cedar Creek wetland system to Cedar Creek Reservoir. Under CA 08-5035C, TRWD may divert 100,465 ac-ft/yr or a maximum of 11,398 ac-ft/month from the Richland-Chambers wetland system to Richland - Chambers Reservoir. The impact of including the Richland-Chambers and Cedar Creek wetland systems was evaluated at their maximum monthly diversion rate over a 3 and 6 month time period.

Table 5-6
Water Quality Concentrations in Cedar Creek Reservoir with Wetland Effluent and the Inclusion of 102 MGD of Lake Palestine Water

						Cedar Creek Historical Volume by Percentile (acre-feet)			Cedar Creek Volume by Percentage of Conservation Storage (acre-feet)		
						50th	75th	90th	50%	75%	90%
						619,743	636,241	639,596	322,393	483,589	580,307
	Parameter	Background Concentrations Time Period	Cedar Creek	Wetland	Palestine	Cedar Creek Parameter Concentrations after Blending Wetland Effluent and 102 MGD of Lake Palestine Water					
Treatability Parameters	Alkalinity (mg/L)	3 Month	59.59	121.26	37.50	61.25	61.21	61.20	62.55	61.67	61.35
		6 Month	61.82	113.02	37.85	63.92	63.87	63.86	65.35	64.40	64.04
	Dissolved Iron (ug/L)	3 Month	26.14	---	110.00						
		6 Month	78.73	---	110.00						
	Dissolved Manganese (ug/L)	3 Month	132.43	---	250.00						
		6 Month	82.61	---	250.00						
	Hardness (mg/L)	3 Month	50.00	171.96	40.00	54.72	54.61	54.59	58.42	55.91	55.01
		6 Month	50.00	167.41	47.67	58.91	58.72	58.68	64.98	60.94	59.42
	Total Dissolved Solids (mg/L)	3 Month	130.46	---	138.60						
		6 Month	131.71	---	138.41						
	Total Organic Carbon (mg/L)	3 Month	6.94	---	8.63						
		6 Month	6.91	---	8.50						
	pH	3 Month	8.20	---	7.65						
		6 Month	8.10	---	7.55						
Nutrient Parameters	Chlorophyll-A (ug/L)	3 Month	34.07	---	42.83						
		6 Month	30.21	---	39.39						
	Dissolved Oxygen (mg/L)	3 Month	5.56	---	5.26						
		6 Month	6.21	---	5.51						
	Nitrite + Nitrate (mg/L)	3 Month	0.03	0.11	0.38	0.05	0.05	0.05	0.06	0.05	0.05
		6 Month	0.07	0.20	0.42	0.11	0.11	0.11	0.13	0.12	0.11
	Orthophosphate Phosphorus (mg/L)	3 Month	0.04	0.82	0.06	0.08	0.08	0.08	0.10	0.08	0.08
		6 Month	0.03	0.60	0.06	0.08	0.08	0.08	0.11	0.09	0.08
	Total Phosphorus (mg/L)	3 Month	0.11	0.81	0.08	0.14	0.14	0.14	0.16	0.15	0.14
		6 Month	0.10	0.61	0.10	0.14	0.14	0.14	0.17	0.15	0.15
	Secchi Depth (m)	3 Month	0.76	---	0.82						
		6 Month	0.78	---	0.77						
	Temperature (°C)	3 Month	28.63	---	28.20						
		6 Month	26.72	---	26.04						

Table 5-7
Water Quality Concentrations in Richland-Chambers Reservoir with Wetland Effluent and the Inclusion of 102 MGD of Lake Palestine Water

						Richland-Chambers Volume by Percentile (acre-feet)			Richland-Chambers Volume by Percentage of Conservation Storage (acre-feet)		
						50th	75th	90th	50%	75%	90%
						1,110,070	1,138,876	1,154,625	568,300	852,450	1,022,940
		Background Concentrations				Richland-Chambers Parameter Concentrations after Blending Wetland Effluent and 102 MGD of Lake Palestine Water					
	Parameter	Time Period	Richland-Chambers	Wetland	Palestine						
Treatability Parameters	Alkalinity (mg/L)	3 Month	86.25	121.26	37.50	86.08	86.08	86.08	85.92	86.03	86.06
		6 Month	90.51	113.02	37.85	89.31	89.34	89.35	88.38	89.00	89.22
	Dissolved Iron (ug/L)	3 Month	33.91	---	110.00						
		6 Month	40.53	---	110.00						
	Dissolved Manganese (ug/L)	3 Month	35.64	---	250.00						
		6 Month	30.62	---	250.00						
	Hardness (mg/L)	3 Month	95.00	171.96	40.00	95.89	95.87	95.86	96.66	96.14	95.96
		6 Month	95.00	167.41	47.67	96.81	96.77	96.75	98.23	97.29	96.95
	Total Dissolved Solids (mg/L)	3 Month	153.48	---	138.60						
		6 Month	159.36	---	138.41						
	Total Organic Carbon (mg/L)	3 Month	5.39	---	8.63						
		6 Month	5.41	---	8.50						
	pH	3 Month	8.10	---	7.65						
		6 Month	8.07	---	7.55						
Nutrient Parameters	Chlorophyll-A (ug/L)	3 Month	21.10	---	42.83						
		6 Month	20.98	---	39.39						
	Dissolved Oxygen (mg/L)	3 Month	4.85	---	5.26						
		6 Month	5.48	---	5.51						
	Nitrite + Nitrate (mg/L)	3 Month	0.03	0.11	0.38	0.04	0.04	0.04	0.05	0.04	0.04
		6 Month	0.06	0.20	0.42	0.08	0.08	0.08	0.10	0.09	0.08
	Orthophosphate Phosphorus (mg/L)	3 Month	0.02	0.82	0.06	0.04	0.04	0.04	0.06	0.05	0.04
		6 Month	0.01	0.60	0.06	0.05	0.05	0.05	0.08	0.06	0.05
	Total Phosphorus (mg/L)	3 Month	0.08	0.81	0.08	0.11	0.10	0.10	0.12	0.11	0.11
		6 Month	0.08	0.61	0.10	0.11	0.11	0.11	0.13	0.12	0.11
Secchi Depth (m)		3 Month	0.93	---	0.82						
		6 Month	0.88	---	0.77						
Temperature (°C)		3 Month	27.80	---	28.20						
		6 Month	26.11	---	26.04						

5.3 Environmental Water Quality Evaluation Results

The impact on each receiving reservoir was evaluated under volume conditions equal to the 50th, 75th, and 90th percentile of historical volume and at 50%, 75%, and 90% of the conservation storage capacity. The historical water quality concentrations and calculated concentrations from the mass balance for the reservoirs and the wetland system were evaluated and the results are presented below.

As noted in the 2006 Region C Water Plan, in general, East Texas reservoirs such as Lake Palestine have higher concentrations of nutrients than the evaluated receiving reservoirs discussed below. The Region C Water Plan notes that all of the water management strategies involving importation of water from East Texas were considered to have "low" or "medium-low" impacts on key water quality parameters.

5.3.1 Lake Benbrook

Although not considered to be a highly probable operational scenario, directly blending 102 MGD of Lake Palestine water with Lake Benbrook would have the following impacts:

- An increase to dissolved iron, dissolved manganese, nitrite + nitrate, and orthophosphate phosphorus concentrations in Lake Benbrook;
- Lesser impact to alkalinity, total organic carbon, chlorophyll-A, and total phosphorus; and
- Improvement to hardness and total dissolved solids concentrations with the addition of Lake Palestine water.

5.3.2 Cedar Creek Reservoir

Blending 102 MGD of Lake Palestine water with Cedar Creek Reservoir would have the following impacts:

- An increase to the nitrite + nitrate concentration in Cedar Creek Reservoir;
- Lesser impact to alkalinity, dissolved iron, dissolved manganese, chlorophyll-A, and orthophosphate phosphorus; and
- Negligible impacts, both positive and negative, to hardness, total dissolved solids, total organic carbon, and total phosphorus.

With the inclusion of the wetland system and the blending of Lake Palestine water: nitrite + nitrate, orthophosphate phosphorus would increase from the historical concentration levels. Hardness would also increase from the historical concentration but to a lesser degree. Alkalinity will improve with the inclusion of the wetland system and the blending of Lake Palestine water.

5.3.3 Richland-Chambers Reservoir

Blending 102 MGD of Lake Palestine water with Richland-Chambers Reservoir would have the following impacts:

- An increase to the dissolved manganese and nitrite + nitrate concentration in Richland-Chambers Reservoir;
- Lesser negative impact to alkalinity, dissolved iron, total organic carbon, chlorophyll-A, and orthophosphate phosphorus;
- Improvement to the hardness in Richland-Chambers Reservoir with the addition of Lake Palestine water; and
- Negligible impacts, both positive and negative, to total dissolved solids and total phosphorus.

With the inclusion of the wetland system and the blending of Lake Palestine water nitrite + nitrate, orthophosphate phosphorus, and the total phosphorus would increase from the historical concentration. The negative impact to alkalinity and hardness from the historical concentration would be negligible with the inclusion of the wetland system and the blending of Lake Palestine water.

5.3.4 Joe Pool Lake

Blending 102 MGD of Lake Palestine water with Joe Pool Lake would:

- Increase dissolved manganese, chlorophyll-A, nitrite + nitrate, and orthophosphate phosphorus concentrations in Joe Pool Lake
- Negatively impact, though to a lesser extent, alkalinity, dissolved iron, total organic carbon, and total phosphorus; and
- Improve hardness and total dissolved solids concentrations with the addition of Lake Palestine water.

Section 6
Water Treatment Considerations

Blending TRWD and DWU raw water supplies would impact raw water quality and potentially the treatment requirements at water treatment plants that receive raw water from these entities. The purpose of this raw water treatment review and treatability analysis was to consider several potential scenarios of blending and transmission that would cause water quality changes that may require modifications to the existing water treatment plant processes.

The four project conveyance alternatives, described in **Table 1-1**, are reproduced below for the reader's convenience.

Alternative	Description
1 (Baseline)	Independent Systems: TRWD's East Texas Third Pipeline and DWU's connection of Lake Palestine to the proposed Southeast Water Treatment Plant
2 (Baseline)	Independent Systems: TRWD's East Texas Third Pipeline and DWU's connection of Lake Palestine to Joe Pool Lake
3 (Interconnection)	Integrated System: Interconnected Third Pipeline (upsized as compared to the baseline condition) with connection of Lake Palestine to Cedar Creek Reservoir and delivery to DWU at Joe Pool Lake and TRWD's customers through the Third Pipeline
4 (Interconnection)	Integrated System: Interconnected "Southern Pipeline" - Lake Palestine delivered to the Lake Benbrook area via a pipeline route to the south of the TRWD Third Pipeline route. Delivery to DWU at Joe Pool Lake and TRWD's customers through connections to the existing system and the Lake Benbrook pipeline.

In the two Baseline alternatives, TRWD would continue to provide raw water to its customer treatment facilities and DWU would deliver raw water to either the proposed Southeast Water Treatment Plant or to the Joe Pool Lake vicinity, for treatment nearby at a new water treatment plant or at the Dallas Bachman WTP. This is also the case for the two Interconnection alternatives with the exception that it was assumed DWU would deliver raw water only to the Joe Pool Lake area for treatment nearby at a new facility or at the Dallas Bachman WTP.

Due to the unlimited possible combinations of source water blends, this treatment evaluation confined the assumed blends to Lake Palestine water discharged solely into one of the four reservoirs: Richland-Chambers, Cedar Creek, Joe Pool or Benbrook. It was further assumed that water supplied from Richland-Chambers Reservoir and Cedar Creek Reservoir would be blended at a 2:1 ratio, similar to typical existing operations.

6.1 Water Quality Parameters of Concern

Raw water quality parameters that could impact treatment processes primarily include alkalinity, hardness, total organic carbon (TOC), total dissolved solids (TDS), bromide, iron, and manganese. The potential impacts of each of these parameters are discussed below.

Alkalinity. Alkalinity is a measure of water's ability to neutralize acid - its buffering capability. Waters with low alkalinity are typically more difficult to treat. Lower alkalinity waters will also require additional TOC reduction per the EPA Stage 1 Disinfectants/Disinfection Byproduct Rule (D/DBPR). Low alkalinity waters would also impact the design of, and materials used in, the transmission systems.

Hardness. Waters with high levels of hardness may require implementation of a softening process at the treatment plant. Such processes are more costly to construct and operate than conventional plants. For example, lime softening process produces significantly greater amounts of sludge that must be handled. Hardness levels are not a concern for any of the TRWD or DWU raw water supplies and were therefore assumed to not be an issue in this evaluation.

Total Organic Carbon. TOC levels have a direct impact on disinfection byproduct (DBP) formation. Raw water with a higher concentration of TOC will result in greater formation of regulated DBPs. Although TOC is not specifically regulated, a certain percentage of TOC reduction is required by the D/DBPR, and higher levels of raw water TOC require higher rates of TOC reduction.

Total Dissolved Solids. TDS is a measure of the concentration of minerals in the water. The Federal Secondary Standard for TDS is 500 mg/L and the TCEQ Secondary Standard is 1000 mg/L. Raw water supplies with TDS levels higher than the secondary standards would require higher-level treatment processes, such as reverse osmosis. TDS levels are not a problem for any of the TRWD or DWU raw water supplies and were not considered in this evaluation.

Bromide. Although Bromide is not a regulated parameter, its presence in raw water, can trigger a reaction with ozone to form bromate, a regulated compound. If the bromate concentration exceeds 10 ug/L, control techniques must be implemented, applied ozone dose reduced, or the ozonation process removed. Most of the WTPs that would be impacted by the interconnection of the raw water transmission system use ozonation as part of the treatment process.

Iron and Manganese. Iron and manganese are metals primarily associated with aesthetic water quality concerns, such as metallic tastes and staining of plumbing fixtures and laundry. Iron and manganese are regulated as secondary standards, with maximum levels of 0.3 mg/L and 0.05 mg/L respectively. Waters with higher levels of iron and manganese require removal, typically oxidation by aeration or with chlorine dioxide or permanganate. Ozone will also oxidize iron and manganese, but would typically not be added specifically for this purpose.

6.2 Reservoir Water Quality

Water quality parameters for the various reservoirs are summarized in Section 5. For purposes of this treatability analysis, the six month average water quality data between June and November were used. The reservoir water quality data are summarized below in **Table 6-1**.

Table 6-1
Reservoir Water Quality

Water Quality Parameter	Lake Palestine	Cedar Creek Reservoir	Richland-Chambers Reservoir	Lake Benbrook	Joe Pool Lake	Elm Fork Trinity River
Alkalinity (mg/L)	38	62	91	107	106	110
Hardness (mg/L)	48	50	95	140	153	140
TOC (mg/L)	8.5	6.9	5.4	5.3	4.8	5.0
TDS (mg/L)	138	132	159	189	313	N/A
Bromide (mg/L)	0.12	0.09	0.09	0.12	N/A	0.13
Iron (ug/L)	110	79	41	23	59	<100
Manganese (ug/L)	250	83	31	25	90	N/A

The Baseline and Interconnected water supply alternatives would result in changes to water quality that differ from the current raw water supplies provided to the TRWD customer water treatment plants and the DWU Bachman water treatment plant. This analysis used the blended water quality data presented in the Espey Consultants May, 2008 technical memorandum and used the **50th percentile reservoir volume** scenarios. A summary of water quality for each alternative is presented below.

6.3 DWU Water Treatment Considerations, Baseline Alternatives 1 and 2

The Baseline alternatives include taking raw water either directly from Lake Palestine to a new Southeast Water Treatment Plant (SEWTP) (Alternative 1), or taking Lake Palestine water to Joe Pool Lake for treatment at a new treatment plant nearby or at the Bachman WTP (Alternative 2). Therefore, in Baseline Alternative 1 water quality at the proposed SEWTP would be the same as Lake Palestine water quality. In Baseline Alternative 2, it was assumed that water would be taken from the pipeline prior to discharging into Joe Pool Lake. Therefore, water quality at a new treatment plant at Joe Pool Lake, or at the Bachman WTP, would be the same as Lake Palestine water.

Table 6-2 presents calculated water quality delivered to Dallas water treatment plants for these two Baseline alternatives and, for comparative purposes, the current raw water quality at the Bachman WTP.

Table 6-2
Water Quality with Implementation of DWU Baseline Alternative

Water Quality Parameter	SEWTP, New WTP near Joe Pool Lake, and Bachman WTP from Lake Palestine	Lake Palestine/Joe Pool Lake Blend (1)	Current Bachman Raw From Trinity River
Alkalinity (mg/L)	38	89	110
Hardness (mg/L)	48	127	140
TOC (mg/L)	8.5	5.7	5.0
TDS (mg/L)	138	270	
Bromide (mg/L)	0.12	–	0.13
Iron (ug/L)	110	72	<100
Manganese (ug/L)	250	130	

Note (1): The water quality blend illustrated in this column would only be applicable to a new water treatment plant near Joe Pool Lake or the Bachman WTP if a blend of Lake Palestine and Joe Pool Lake waters were used.

6.4 TRWD Water Treatment Considerations, Baseline Alternatives 1 and 2

For TRWD, Baseline Alternatives 1 and 2 include adding a Third Pipeline to carry raw water from Cedar Creek and Richland-Chambers Reservoirs (including water supply augmentation from the constructed wetlands) to its customers. TRWD would continue to use Lake Benbrook as terminal storage, primarily for the Fort Worth Rolling Hills WTP and future Westside WTP. Under the baseline alternatives, TRWD customers would not see a significant change in the water treatment parameters. **Table 6-3** presents potential water quality blends delivered to TRWD customer water treatment plants for the Baseline Alternatives 1 and 2. The Richland-Chambers/Cedar Creek blend was assumed to be a 2:1 blend ratio.

Table 6-3
Water Quality with Implementation of TRWD Baseline Alternative

Water Quality Parameter	Cedar Creek Reservoir	Richland-Chambers Reservoir	Cedar Creek/ Richland-Chambers Blend	Lake Benbrook
Alkalinity (mg/L)	62	91	81	107
Hardness (mg/L)	50	95	80	140
TOC (mg/L)	6.9	5.4	5.9	5.3
TDS (mg/L)	132	159	154	189
Bromide (mg/L)	0.09	0.09	0.09	0.12
Iron (ug/L)	79	41	54	23
Manganese (ug/L)	83	31	48	25

6.5 Interconnection Alternative 3 Water Treatment Considerations – Lake Palestine to Cedar Creek Reservoir

Under this Interconnection alternative, Lake Palestine water would be pumped to Cedar Creek Reservoir. The Lake Palestine/Cedar Creek blend may then be combined with Richland-Chambers water in the transmission system before delivery to TRWD customers and before delivery to DWU at Joe Pool Lake (for treatment nearby at a new WTP or at Bachman WTP). For this analysis, the raw water was assumed to be a 2:1 blend of water originating from Richland-Chambers Reservoir and Cedar Creek Reservoir (including Lake Palestine). **Table 6-4** presents potential water quality delivered through the interconnected system for this alternative.

Table 6-4
Water Quality with Delivery of Lake Palestine to Cedar Creek

Water Quality Parameter	Lake Palestine	Cedar Creek Reservoir	Lake Palestine/ Cedar Creek Blend	Richland-Chambers Reservoir	Cedar Creek/ Richland-Chambers Blend
Alkalinity (mg/L)	38	62	60	91	81
Hardness (mg/L)	48	50	50	95	80
TOC (mg/L)	8.5	6.9	7.0	5.4	5.9
TDS (mg/L)	138	132	132	159	150
Bromide (mg/L)	0.12	0.09	–	0.09	–
Iron (ug/L)	110	79	81	41	54
Manganese (ug/L)	250	83	97	31	53

6.6 Interconnection Alternative 4 Water Treatment Considerations – Lake Palestine to Lake Benbrook

Under this Interconnection alternative (the "southern pipeline"), Lake Palestine water could be pumped directly to the Lake Benbrook area bypassing Richland-Chambers and Cedar Creek during certain system operations. The Lake Palestine water could then be supplied to the Fort Worth Rolling Hills WTP and Westside WTP. Prior to reaching the Lake Benbrook area, Lake Palestine water could also supply the future Fort Worth Southwest WTP. All three of these plants could also be supplied from Cedar Creek Reservoir and Richland-Chambers Reservoir which would include blends of Lake Palestine and constructed wetlands waters. Other TRWD customers would continue to receive water directly from Richland-Chambers and Cedar Creek Reservoirs through the existing TRWD transmission pipelines.

Lake Palestine water from the southern pipeline would also be provided to the Joe Pool Lake area to supply the Bachman WTP or other new treatment facilities. The potential delivery of Lake Palestine water directly to the Lake Benbrook area is considered to be an infrequent possibility since it assumes the direct transfer of unblended Lake Palestine water to the outermost edge of the study area. Nevertheless, it provides the most extreme blending scenario in terms of water treatment considerations for an integrated system for some of the TRWD customers.

Table 6-5 presents potential water quality delivered through Interconnection Alternative 4 for this blending scenario. It also shows the water quality if Lake Palestine water were blended with Lake Benbrook water. Due to permitting and contract issues, this is not considered a likely scenario in the foreseeable future.

Table 6-5
Water Quality with Delivery of Lake Palestine to the Lake Benbrook Area

Water Quality Parameter	Fort Worth WTPs from Lake Palestine	Lake Benbrook	Lake Palestine/ Lake Benbrook Blend (1)
Alkalinity (mg/L)	38	107	78
Hardness (mg/L)	48	140	102
TOC (mg/L)	8.5	5.3	6.6
TDS (mg/L)	138	189	168
Bromide (mg/L)	0.12	0.12	–
Iron (ug/L)	110	23	59
Manganese (ug/L)	250	25	117

Note (1): For informational purposes. Not a likely scenario.

6.7 Treatability Issues

The Baseline and Integrated water supply alternatives present changes in raw water quality that will impact the treatment processes at the water treatment plants and could increase operational costs and potentially require additional capital expenditures. A discussion of the treatability issues for each project conveyance alternative follows.

6.7.1 Baseline Alternatives

Under Baseline Alternatives 1 and 2, WTPs currently receiving raw water from TRWD would continue to receive water delivered from Richland-Chambers Reservoir and Cedar Creek Reservoir, both of which would also include constructed wetlands augmentation in the future. The Fort Worth Rolling Hills WTP and future Westside WTP would also continue to receive water from Lake Benbrook under seasonal operational scenarios. No impact to water quality or treatability related to Lake Palestine would occur under this scenario.

Under Baseline Alternatives 1 and 2, either the proposed DWU Southeast WTP, new WTP near Joe Pool Lake, or the Bachman WTP would receive raw water directly from Lake Palestine. This water quality would be significantly different from the Elm Fork of the Trinity River raw water currently supplied to the Bachman WTP. The DWU WTPs could expect the following water quality and treatability issues under Alternatives 1 and 2:

- The raw water alkalinity would be less than 60 mg/L, limiting the raw water's buffering capability and making it more difficult to treat. The TOC would be above 8.0 mg/L, meaning that 50% of the TOC must be removed during the treatment process or an alternative minimum TOC removal requirement must be implemented. The proposed SEWTP could expect to use greater amounts of coagulant than those currently used at the Bachman WTP. Bench scale studies would be required to determine the actual amounts of coagulant required.

- The high levels of TOC raise the potential for high levels of disinfection byproduct (DBP) formation. If ozonation were to be used as the primary disinfectant (as at the Bachman WTP) and chloramine as the residual disinfectant, the plant should be able to control DBPs successfully.

- Iron levels from Lake Palestine water are somewhat elevated, but fall within the regulatory secondary standards. Plants utilizing ozone or chlorine dioxide would oxidize some of the iron, thereby reducing the iron content in the finished water.

- Manganese levels from Lake Palestine are well above the regulatory secondary drinking water standards. These manganese levels could be reduced to below the regulatory standards through oxidation with ozone, if it were applied similar to methods used at the Bachman WTP. However, care would be required to limit the potential for conversion of the manganese to permanganate, which could result in pink water. The use of biological filtration following the ozonation process has shown to be effective for manganese reduction. It is anticipated that approximately 0.25 mg/L of additional ozone dose would be required to provide the desired manganese oxidation. This would be in addition to the dosage required for disinfection and taste and odor control.

If under Baseline Alternative 2 the Lake Palestine water were pumped directly into Joe Pool Lake and then delivered to a new WTP near Joe Pool Lake or the Bachman WTP, the water quality parameters would be similar to current raw water quality from the Elm Fork of the Trinity River. This blending scenario was considered to provide insight into the impact of such a diversion.

- Raw water alkalinity of about 89 mg/L and TOC of 5.7 mg/L would require TOC reduction of 35%. This water would be more easily treated than the raw water directly from Lake Palestine.

- The TOC would be in line with current levels and should not present significant DBP formation issues, especially with the use of ozone and chloramine for disinfection.

- Manganese levels would still be elevated, although less than those associated with direct use of Lake Palestine water. The additional dose of ozone required for oxidation of manganese would be approximately 0.1 mg/L.

Treatability issues related to the Baseline alternatives would result in little impact to the TRWD customers, but would impact the DWU plants (and possibly any other water treatment plants using Joe Pool Lake in one alternative). Sending Lake Palestine raw water directly to the proposed Southeast WTP, Bachman WTP, or a new WTP near Joe Pool would have the greatest impact on the cost of operating the plant and meeting regulatory requirements.

6.7.2 Interconnection Alternative 3 / Water Treatment Scenario 1 – Lake Palestine to Cedar Creek Reservoir

Under this scenario, the blended Lake Palestine and Cedar Creek Reservoir raw water would be similar to the Cedar Creek raw water currently being provided to the TRWD customers. The only constituent of potential concern in this blend, related to water treatment, is manganese. However, as discussed above in the Baseline alternatives, oxidation with ozone would be an effective treatment process for reducing the manganese level. Minimal (if any) additional ozone would be required to oxidize the manganese. The Mansfield WTP does not use ozonation as part of its treatment process. However, it does use chlorine dioxide, which is at least as effective as ozone in oxidizing manganese.

Also under this scenario, the DWU Bachman WTP or new plant near Joe Pool Lake would be provided with the same water quality as the TRWD plants from the Third Pipeline. This water quality would be similar to the DWU Baseline Alternatives 1 and 2 discussed in Section 6.4, and the same water quality and treatment issues apply.

6.7.3 Interconnection Alternative 4 / Water Treatment Scenario 2 – Lake Palestine to Lake Benbrook

Under this worst case, low probability operational scenario, raw water from Lake Palestine would feed the Fort Worth Rolling Hills WTP and future Westside WTP. The Lake Palestine water would be similar to the more difficult Cedar Creek Reservoir water that the Rolling Hills WTP sometimes receives, except for the elevated iron and manganese levels. The treatability issues would be the same as those presented in the DWU Baseline alternative with low alkalinity, high TOC and elevated manganese levels. Additional coagulation chemicals would likely be required to treat this water. The ozonation process, in place at the Rolling Hills WTP, should oxidize the manganese for removal in the sedimentation and biological filtration processes of the plant. Under this scenario, the future Fort Worth Southwest WTP could also receive Lake Palestine raw water directly from the Southern Pipeline.

6.8 Summary and Conclusions

Integrating Lake Palestine water into the DWU and TRWD raw water supply systems would have a low to moderate impact on water quality and treatment at the existing and proposed water treatment plants. The major impacts of the Lake Palestine water relate to its low alkalinity, high TOC, and high manganese concentrations.

Implementing the Baseline alternatives would create no impact to water quality or treatability at the existing plants currently being served by TRWD since the supply sources would be the same (except for the planned implementation of the constructed wetlands project). The DWU Baseline alternative, with Lake Palestine water exclusively, would result in raw water at the proposed Southeast WTP, new WTP near Joe Pool Lake, or the Bachman WTP that is more difficult to treat when compared to the City's existing Bachman WTP. The low alkalinity would require greater amounts of coagulant for treatment. The higher TOC level would present more difficulty in meeting DBP requirements. The low alkalinity coupled with the relatively high TOC would require greater TOC reduction and most likely greater coagulant use. The high manganese levels would require greater, although not significant, ozone use for oxidation and removal of manganese. Although the Lake Palestine water is anticipated to be more difficult to treat, the overall treatment process could be similar to the current DWU plants, like Bachman WTP. The operational costs would be slightly greater due to increased ozone and coagulant requirements.

Implementing water quality scenario 1 in Interconnection Alternative 3 (described in Section 6.7.2) presents no major water quality issues that would adversely impact treatability or require significant increases in operational costs. The only constituent of concern is manganese, and it could be mitigated either through blending controls or oxidized through the current plant treatment processes.

The less probable water quality scenario 2 in Interconnection Alternative 4 (described in Section 6.7.3) results in the least favorable water quality for TRWD customer plants and presents the most treatability concerns of the integrated water quality scenarios and is provided as a "worst" case. The Fort Worth Rolling Hills and Westside WTPs could seasonally be provided with water with low alkalinity, high TOC, and relatively high manganese levels. Although the ozonation processes at both plants would oxidize the manganese, it would require closer management to effectively monitor and control the process and would result in greater costs for operation. This water quality scenario also could provide the proposed Fort Worth Southwest WTP with Lake Palestine raw water.

Section 7
Permitting and Regulatory Review

7.1 Introduction

This section presents a summary of the water rights and regulatory considerations for the various facilities considered in this Project Viability Assessment and as such represents a "fatal flaw" and due diligence review for this conceptual analysis.

7.2 Water Rights

7.2.1 Lake Palestine

- The Lake Palestine water right fully authorizes the interbasin transfer of up to a total of 132,337 ac-ft/yr from the Neches River Basin into the Trinity River Basin for municipal and industrial use, with no restrictions on where the water can be used or by whom.

- Any water diverted to the Trinity River Basin from the 18,000 ac-ft/yr of industrial water that is authorized for diversion from the Downstream Diversion Reservoir under the Lake Palestine water right that is not consumed must be returned "to an unnamed tributary of Cedar Creek, tributary of Trinity River" to one of two locations specified in Paragraph 7 of the Certificate of Adjudication. This means that most, if not all, of the diversions to the Trinity River Basin under the Lake Palestine water right should come from Lake Palestine.

- The maximum diversion rate for diversions from Lake Palestine is 518 cfs, which may limit how much water can be diverted to the Trinity River Basin when considered with other diversions that are made from the reservoir for other water users and customers of the Upper Neches River Municipal Water Authority.

- The priority dates for the interbasin transfer of water from Lake Palestine to the Trinity River Basin are relatively junior (1972 and 1983), compared to the primary priority date for impounding and using water in Lake Palestine (1956).

- None of the existing reservoirs in the Trinity River Basin being considered as potential terminal storage reservoirs for the Lake Palestine water are currently authorized for such storage, including Cedar Creek Reservoir, Richland-Chambers Reservoir, Lake Benbrook, Eagle Mountain Lake, and Joe Pool Lake.

- Lake Benbrook on the Trinity River Clear Fork and Eagle Mountain Lake on the Trinity River West Fork are authorized to store water delivered from Cedar Creek and Richland-Chambers Reservoirs.

- New water rights permits or amendments to existing reservoir water rights in the Trinity River Basin will be required to authorize the storage and use of Lake Palestine water by the City of Dallas and the Tarrant Regional Water District.

- The use of Joe Pool Lake for terminal storage of the Lake Palestine water will require contractual agreements with the U. S. Army Corps of Engineers (reservoir owner) and the Trinity River Authority (water right owner).

- The use of natural stream courses for conveying Lake Palestine water to storage reservoirs or end users in the Trinity River Basin will require "bed and banks" permits from the Texas Commission on Environmental Quality.

- Authorization for the indirect reuse of return flows from the use of Lake Palestine water for municipal or industrial purposes will need to be included in water rights permits associated with the Project.

7.2.2 Cedar Creek Reservoir

- Cedar Creek Reservoir is authorized to receive water from the TRWD constructed wetlands project. This indirect reuse project to naturally treat wastewater return flows is expected to add 52,500 acre-feet per year to the reservoir.

7.2.3 Richland-Chambers Reservoir

- Richland-Chambers Reservoir is authorized to receive water from TRWD constructed wetlands like Cedar creek Reservoir, adding 63,000 acre-feet per year to Richland-Chambers.

7.2.4 Lake Arlington

- The amended certificate of adjudication (CA) for Lake Arlington indicates that the co-owners of Lake Arlington are the City of Arlington and Texas Utilities Electric Company. It is our understanding that the CA has been assigned from TXU US Holdings Company to ExTex LaPorte. Current ownership of the CA and the reservoir may therefore be different than indicated on the CA.

7.2.5 Lake Benbrook

- Lake Benbrook is owned by the U.S. Army Corps of Engineers and the CA is owned by TRWD which has contracted with the Corps for water supply storage. Using Lake Benbrook for terminal storage of Lake Palestine water will require approval and arrangements between the two parties. This agreement may require federal approval pursuant to the Water Supply Act.

7.2.6 Joe Pool Lake

- Joe Pool Lake is owned by the U.S. Army Corps of Engineers and the CA is owned by the Trinity River Authority. Using Joe Pool Lake for terminal storage of Lake Palestine water will require approval and arrangements between the two parties and may federal approval pursuant to the Water Supply Act. The City of Grand Prairie, City of Duncanville, Midlothian Water District, and City of Cedar Hill have contractual rights to water from Joe Pool Lake.

- **Contract/Contractual Permit/Agreement 1421**. Owned by the City of Grand Prairie. Allows diversions of 1,795 af per year for municipal and domestic uses. Issue date May 22, 1984 and priority date June 15, 1977**.**

- **Contract/Contractual Permit/Agreement 1422**. Owned by the City of Duncanville. Allows diversions of 1,197 af per year for municipal and domestic uses. Issue date May 22, 1984 and priority date June 15, 1977.

- **Contract/Contractual Permit/Agreement 1423**. Owned by the Midlothian Water District. Allows diversions of 6,662 af per year for municipal and domestic uses. Issue date May 22, 1984 and priority date June 15, 1977.

- **Contract/Contractual Permit/Agreement 1424**. Owned by the City of Cedar Hill. Allows diversions of 7,346 af per year for municipal and domestic and industrial uses. Issue date May 22, 1984 and priority date June 15, 1977.

7.3 Federal Permits

- The construction of pumping and conveyance facilities and regulating reservoirs required for delivering Lake Palestine water to the Trinity River Basin users will require a permit(s) under Section 404 of the Clean Water Act to the extent that the discharge of dredged and fill material adversely impacts United States' waters.

- The required Section 404 permit(s) may be "individual" permit(s) tailored specifically for the facilities and impacts associated with the Project or they may be "general" or "nationwide" permits provided the Project facilities and associated impacts qualify.

- Potentially available nationwide permits:

    1. No. 12 – Utility Line Construction impacting less than one-half acre of United States' water.

    2. No. 18 – Minor Discharges of Dredged or Fill Material involving less than 25 cubic yards of material and impacting less than one-tenth acre of United States' waters.

- Pipeline crossings of navigable streams as part of the Project will require a permit(s) under Section 10 of the River and Harbors Act of 1899.

- The Trinity River in the vicinity of where Project pipelines potentially would cross is classified as being navigable by the Corps of Engineers.

7.4 Application of Section 402 of the Clean Water Act to the Transfer

Section 402 of the Clean Water Act authorizes the NPDES ("National Pollutant Discharge Elimination System"). The NPDES permit program regulates point sources

of pollutant discharges into the waters of the United States. Whether transfers of water such as the envisioned interbasin transfers should be subject to Section 402 has been the subject of extensive litigation. The U.S. Supreme Court addressed this question in 2004 and found that current law requires an NPDES merely for the conveyance of a pollutant from one hydrologically distinct basin to another. *South Florida Water Management Dist. V. Miccosukee Tribe of Indians, 541 U.S. 95 (2204).* More recently, the Second Circuit Court of Appeals found that NPDES permits are required for interbasin transfers. *Catskill Mountains Chapter of Trout Unlimited, Inc. v. City of New York,* 451 F.3d 77 (2nd Cir. 2006)

The EPA subsequently proposed an amendment to the Clean Water Act regulations on June 9, 2006 that would expressly exclude water transfers (including interbasin water transfers) from regulation under the NPDES program. The EPA adopted the final rule declaring that routine transfers of water from one water body to another are not subject to NPDES permitting requirements this June 9, 2008. This rule defines a routine transfer as an activity that conveys waters without subjecting the water to intervening industrial, municipal, or commercial use. The water transfer rule codifies the former EPA interpretation that permits are not required for transfers such as routing water through tunnels, channels, or natural stream courses for public supplies, irrigation, power generation, flood control and environmental restoration. Pollutants introduced by the water transfer activity itself to the water being transferred would still be subject to permitting under the new rule.

The final rule is effective 60 days after it is published in the Federal Register, which is anticipated will be quite soon. If the rule is finalized in its present form, we do not believe a NPDES permit will be required from the Texas Commission on Environmental Quality for the transfer.

7.5 State Permits

Several state permits or agency approvals may be necessary either in conjunction with publicly-funded, or even with privately-funded, project financial sources. Publicly-funded projects often require agency coordination with key federal, state, and regional agencies. This agency coordination is usually performed in conjunction with the National Environmental Policy Act of 1969 (NEPA) and requires coordination with federal agencies and also the key state agencies introduced below. Even those projects that will not seek federal funding may also be impacted by some of the entities listed below, such as projects occurring near impaired water bodies or possibly by other means, as are described below.

- The Texas Commission on Environmental Quality (TCEQ) permitting could impact any project location if it is not adequately pre-screened through Phase I Environmental Site Assessment (ESA) investigation to verify that no contaminated air, water, or waste media are known to exist as recognized environmental conditions at a proposed site. For instance, Total Maximum Daily Load (TMDL) considerations need to be evaluated with respect to known TMDL waterways and also for those potential TMDL stream segments that are soon to be designated and

implemented, in some cases for additional parameters.

Segment 0805 Upper Trinity River, the segment that encompasses the Trinity River from near the confluence of the Elm Fork Trinity River in western Dallas County down to Cedar Creek Reservoir, is classified as impaired by PCBs (bio-accumulated in fish tissue). Segment 0805 is also under recent consideration for a potential bacterial TMDL. Some of the lakes listed above, like Joe Pool Lake and Cedar Creek Reservoir, could be affected by such regulatory action and this needs to be evaluated before any final sites are determined for an inter-basin transfer from Lake Palestine.

Segments 0805 and 0841 (Trinity River) in Dallas and Tarrant Counties are also under the TMDL project for legacy pollutants (such as chlordane, DDT, DDE, dieldrin, heptachlor epoxide, and PCBs in fish tissue) that is under implementation for the Trinity River and the Mountain Creek Lake.

- Texas Historical Commission (THC) is the home to the Texas State Preservation Office (TSPO) that is located in the Capitol Complex north of the Texas Capitol building. The THC is tasked with to preserve the historical, archaeological, architectural, and cultural resources that are protected by state and federal antiquities laws. Federally-funded and even state-funded projects will normally require that the study of proposed sites have a Phase I pedestrian archaeological investigation. At a minimum, proposed sites should have a desktop study of the THC website, to see if any listings are registered for a site or in its direct proximity.

- Texas Parks and Wildlife Department (TPWD) is the state agency that is committed to the preservation and protection of the state's floral and faunal species, in conjunction with the US Fish and Wildlife Service (USFWS). As such, TPWD typically agrees with the lead taken by USFWS for animal species; however, they take the lead for the protection of any protected plant species that might be impacted by the proposed project.

- Texas Water Development Board (TWDB) is the agency that manages the state's regional water planning program. Dallas Water Utilities and Tarrant Regional Water District are both located in Region C, the North Central Texas planning region. Lake Palestine is situated in Region I, the East Texas regional water planning group. Coordination between these Regional Water Planning groups has identified the potential inter-basin transfer of Lake Palestine water from Region I to Region C to satisfy the needs of the Dallas-Fort Worth metropolitan region as early as the Texas Water Plan 2002.

7.6 State Draft Nutrient Regulation

The Texas Commission on Environmental Quality (TCEQ) in conjunction with the U.S. Geological Service (USGS) is currently evaluating options for developing nutrient criteria for consideration by the U.S. Environmental Protection Agency (EPA) and the public during the next triennial revision of the Texas Surface Water Quality Standards (Chapter 307 in Title 30 of the Texas Administrative Code). Texas has no such numerical criteria currently but does address nutrient loadings by applying narrative criteria for permitted discharges by developing watershed rules which require nutrient reductions in wastewater discharges in or near specified water bodies, and by employing TCEQ's anti-degradation policy to increases in discharge loads of nutrients.

For assessing water bodies and regulatory actions, the TCEQ is also evaluating a "weight of evidence" approach to incorporate historical monitoring data for total phosphorous and total nitrogen for individual water bodies. The evaluation of permitted discharges could be based on screening criteria developed from historical data of all of these variables, in addition to the criteria listed in the water quality standard, such as chlorophyll *a*.

TCEQ has formed and is working with a Nutrient Criteria Development Workgroup in order to obtain stakeholder input from state and federal agencies, Texas river authorities, cities, industry, environmental groups, agricultural and other interested parties. Reservoirs have been the TCEQ staff's initial priority. Draft numerical nutrient criteria for the supply and receiving reservoirs considered in this initial viability assessment, as well as for lakes across the state, were provided to the Texas Surface Water Quality Standards Workgroup at their May 5, 2008 meeting.

Procedures to assess standards compliance with monitoring data will be established in both Section 307.9 of the *Texas Surface Water Quality Standards* and the *TCEQ Guidance for Screening and Assessing* Texas Surface Water and Finished Drinking Water Quality Data. Procedures to assess and set loading limits on nitrogen and phosphorus from regulated sources, such as permitted wastewater discharges, will be established in the TCEQ Procedures to Implement the Texas Surface Water Quality Standards.

While these nutrient regulations are still in the draft stages with TCEQ and do not currently apply to the inter-basin transfer of Lake Palestine water to the reservoirs evaluated in this study, all water supply agencies should be closely monitoring this developing regulatory program. Subsequent studies of the efficacy of an integrated raw water transmission system approach between TRWD and DWU will address this developing regulatory program.

Section 8
Dallas Water Utilities Additional Treatment and Water Transmission Facilities

8.1 Introduction

The purpose of this portion of the study was to consider additional cost and treatment implications for transmission of raw water to DWU treatment and distribution system facilities from project conveyance Alternatives 1 and 3, which respectively represent the independent and interconnected raw water transmission system (see **Table 1-1** for a full description of these alternatives). These additional treatment and water transmission facilities that may be required for a fully functional integrated strategy for DWU were beyond the initial study boundary (see **Figure 1-3**); therefore, costs implications in this section are additive to the DWU project conveyance alternative costs. These costs do not include distribution system improvements needed downstream of the water treatment plants. This study of three additional treatment and transmission scenarios (see **Table 8-1**) was guided by the following objectives:

1. Document the criteria that will be used in subsequent phases to select the preferred treatment/transmission scenarios and develop a listing of the applicable constraints to these scenarios (e.g. water quality, cost, and permitting complexity).

2. Develop transmission alternatives and treatment modification costs for **Scenario 1: water delivered to or around Joe Pool Lake and conveyed to the existing Bachman Water Treatment Plant (WTP).** Planning-level treatment modifications at the existing Bachman WTP to treat the water from an integrated raw water system were also considered.

3. Develop treatment costs for **Scenario 2**: **water delivered to, and treated at, the proposed Southeast WTP (SE WTP).** In this scenario, raw water would not be conveyed to or stored in Joe Pool Lake and would instead be delivered directly to the SE WTP from the integrated raw watery transmission system. Transmission costs were not included in this scenario because they were included in Interconnection Alternative 3. Treatment costs were based on construction of the new WTP.

4. Develop treatment costs for **Scenario 3**: **a new WTP located near Joe Pool Lake.** Transmission costs were not included in this scenario because they were included in Interconnection Alternatives 3 and 4. Treatment costs were based upon construction of a new WTP near Joe Pool Lake.

Table 8-1
DWU Additional Treatment and Transmission Facilities Scenarios

DWU Scenario	Conveyance	Treatment	Project Conveyance Alternative[1]
1 Bachman WTP	Delivery to or around Joe Pool Lake and conveyance to Bachman WTP	Possible Bachman WTP Process Modifications; Elm Fork Expansion	3 (Interconnected)
2 Southeast WTP	Conveyance included in Raw Water System Integration costs	New Southeast WTP	1 (Baseline)
3 WTP at Joe Pool	Conveyance included in Raw Water System Integration costs	New Joe Pool Lake WTP	3 (Interconnected)

8.2 Evaluation Criteria

In this section, evaluation criteria relate to the selection of a preferred route for transmission of water to the Bachman WTP and the estimation of costs (both capital and life-cycle) for transmission, new water treatment plants, and modifications or expansions to existing plants. This section describes criteria specific to this analysis and any differences between these criteria and those employed in other analyses in this report.

8.2.1 Transmission Infrastructure

A preliminary facility siting constraints analysis is described in Section 4 of this report to identify potential fatal flaws to locating water transmission facilities along select pipeline corridors and to make a comparison between project conveyance alternatives. Though this same level of data collection and analysis was not applied to the transmission routes to Bachman WTP, the criteria used in subsequent phases for the selection of preferred transmission scenarios, and a listing of the applicable constraints to these scenarios.

Transmission routes for this analysis were developed using limited data collection, including aerial photography, institutional knowledge, topography, and data collected for other tasks in this study. Based on this information, a preferred route was selected for cost evaluation. The basis for the capital and life-cycle cost evaluation is the same as described in Section 3 of this report (as applied to the four project conveyance alternatives for the raw water transmission system). The discount rates and cost of debt used in this life-cycle cost analysis correlate (as shown in **Table 8-1**) with the Project Conveyance Alternative discount rates and costs of debt. For example, the DWU baseline alternative rate of 4.58% was used in Scenario 2 and a

[1] Costs for Scenarios 1 through 3 are additive to the Project Conveyance Alternatives. Cost implications to Project Conveyance Alternatives 2 and 4 are not considered separately here because they fall within the bounds of these results.

discount rate of 4.77% was used for Scenarios 1 and 3 to correlate with Project Conveyance Alternative 3.

8.2.2 Water Treatment

Water treatment plant (WTP) construction and operating costs for the three DWU additional treatment and transmission facilities scenarios were based on the following:

- Raw water quality data (developed in Sections 5 and 6);
- Treatment process scenarios developed for the projected raw water quality;
- Recent construction costs for plants with similar processes on a cost per gallon basis;
- Water treatment costs (chemicals and power) associated with treatment only from similar plants treating similar waters;
- Plant capacity of 102 mgd; and
- Operating costs on a cost per gallon basis.

The treatment process selected for comparing the three DWU additional treatment and transmission facilities scenarios is similar to the Bachman WTP process and other current treatment plants served by TRWD. The treatment process includes the following processes:

- Raw water ozonation for primary disinfection, taste and odor control, and iron and manganese oxidation;
- Conventional treatment processes of rapid mix, flocculation, and sedimentation, using ferric sulfate coagulant with coagulant aid polymer;
- Biological filtration for turbidity reduction and assimilable organic carbon (AOC) removal for biological stability;
- Chloramines for residual disinfection;
- Clearwell storage;
- Lime or caustic for pH adjustment;
- Fluosilicic acid for fluoride addition; and
- Sludge lagoons for sludge handling

.

8.3 Scenario 1 – Bachman WTP

In this analysis, Scenario 1 correlates to the cost and water quality analysis found in Project Conveyance Alternative 3 (Interconnected Third Pipeline). Costs from this scenario are additive to Alternative 3 costs and the raw water used in this scenario is the same as that in Alternative 3, a blend of Lake Palestine and Cedar Creek Reservoir water.

8.3.1 Conveyance Alternative Routes in Scenario 1

Using limited data collection, including aerial photography, institutional knowledge, topography, and data collected for other tasks in this study, five feasible transmission routes were developed to deliver water from the integrated raw water transmission system pipelines to the Bachman WTP. These alternatives (all within Scenario 1) included, closed conduit and open channel pathways, delivery to and delivery around Joe Pool Lake, and conveyance through or around Mountain Creek Reservoir. The assumed take-point from the integrated raw water transmission system was from the approximate confluence of Joe Pool Lake and the Third Pipeline (or existing two pipelines) that delivers water from Cedar Creek and Richland-Chambers Reservoirs to Lake Benbrook.

Ground elevation profiles were developed for the five alternative routes to Bachman WTP using USGS contour information. **Figure 8-1** compares centerline ground elevations of each alternative route in Scenario 1. Each alternative route terminates at the same location (Bachman WTP) but differs in the intake location:

- Alternative route A intake is at the downstream end of Joe Pool Lake;
- Alternative route B intake is at a location downstream of Mountain Creek Lake (upstream of this point it is open channel flow);
- Alternative route C flows through Joe Pool Lake and then by gravity to the Trinity River where, after mixing with Trinity River flow, it is pumped to Bachman WTP;
- The intake location of alternative route D is from the Third Pipeline (or existing pipelines from Richland-Chambers and Cedar Creek Reservoirs) on the southwest side of Joe Pool Lake; and
- The intake location for alternative route E is from the Third Pipeline (or existing pipelines from Richland-Chambers and Cedar Creek Reservoirs) on the southeast side of Joe Pool Lake.

Alternative route D traverses the longest distance from the TRWD pipelines interconnection to the Bachman WTP. In **Figure 8-1,** station 0+00 represents the intake location of this longest alternative route and station 1600+00 represents the end location at the Bachman WTP intake. The pipeline profile was taken into consideration for the comparative analysis of the five alternative routes.

Table 8-2 provides some of the considerations used to develop the five alternative routes in Scenario 1. A schematic alignment of each alternative is provided in **Figure 8-2** through **Figure 8-6**. A more complete explanation of some of the "Advantages" and "Disadvantages" listed in **Table 8-2** is given here:

- The conservation pool of Joe Pool Lake is controlled by the U.S. Army Corps of Engineers in conjunction with the Trinity River Authority (TRA), which has contracted to several local customers. At this time, no storage is available to DWU for Lake Palestine water. Conveying water through Joe Pool Lake therefore has associated permitting, storage and operational issues that will require resolution should this alternative be selected.

- The general assumption in **Table 8-2** is that mixing Lake Palestine water with the Trinity River would degrade the Lake Palestine water quality.

- Alternative E – "TRWD Pipelines to Bachman WTP - SH 360 Alternative" assumes that the SH 360 corridor has available right-of-way to accommodate a pipeline. In March 2008, the North Texas Tollway Authority met with representatives from Texas Department of Transportation's Dallas and Fort Worth districts and the North Central Texas Council of Governments (NCTCOG) to discuss agency partnering and corridor planning for SH 360. The parties agreed to meet regularly to discuss scope and agency responsibilities. A description from www.nctog.org/trans/corridor/studies.asp reads: "The recommended improvements to the SH 360 South Corridor extend from Sublett Road/Camp Wisdom Road to the proposed Dallas-Fort Worth Regional Outer Loop south of US 287, passing through the cities of Arlington, Grand Prairie, and Mansfield. From Sublett Road/Camp Wisdom Road to Debbie Lane, SH 360 is planned to include 8 general purpose toll lanes; between Debbie Lane and the Dallas-Fort Worth Regional Outer Loop, 6 general purpose toll lanes are planned. In addition, the entire corridor will include 4 continuous frontage road lanes. The improvements from Sublett Road/Camp Wisdom Road to US 287 are expected to be completed by 2015, and the improvements from US 287 to the Dallas-Fort Worth Regional Outer Loop are expected to be completed by 2025."

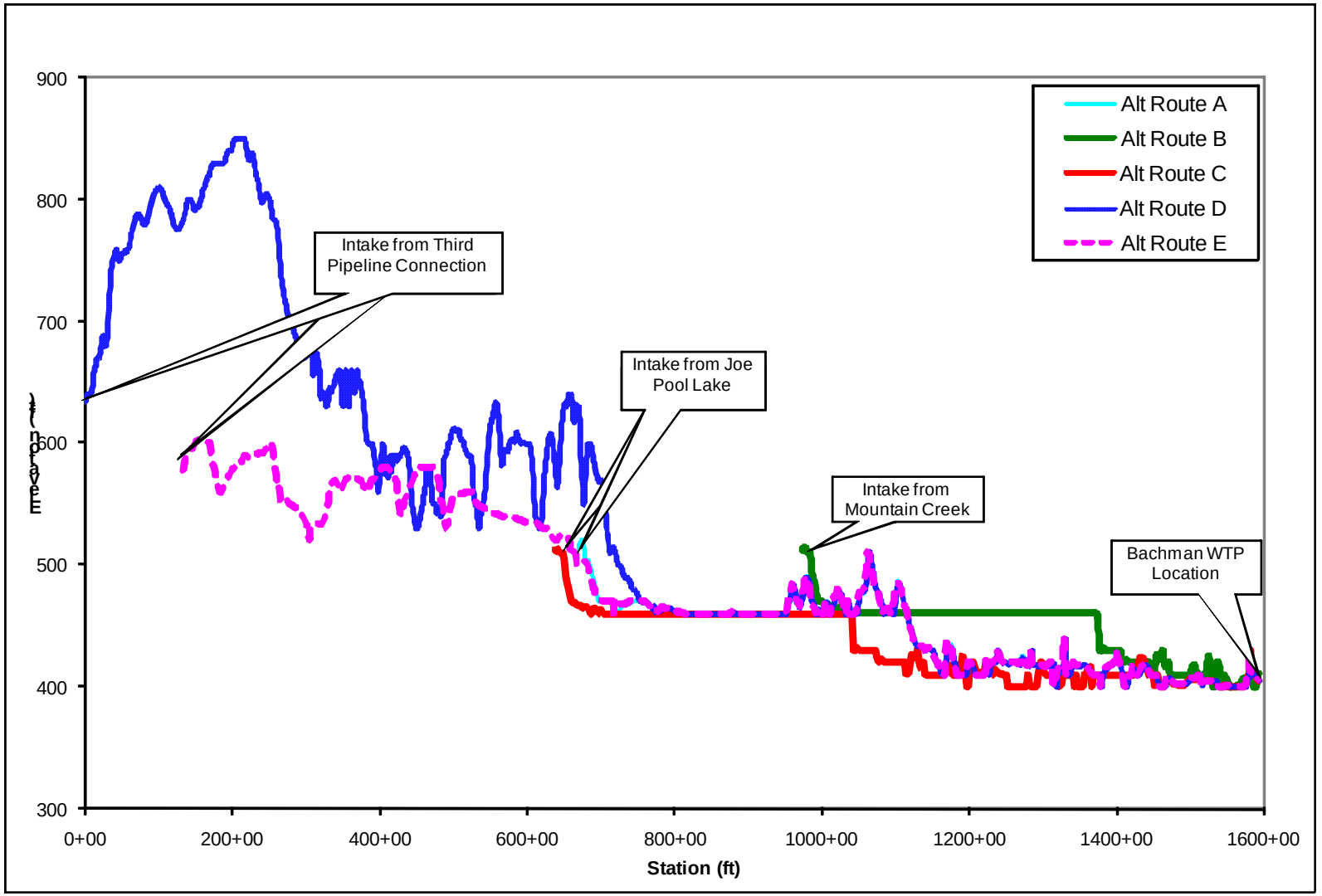


Figure 8-1
Profiles of Scenario 1 Alternative Conveyance Routes to Bachman WTP

Table 8-2
Scenario 1 Alternatives Conveyance Routes

Alternative Route	Description	Type	Pumped Flow Length (ft)	Channel Flow Length (ft)	Advantages	Disadvantages
A	Joe Pool Lake to Bachman WTP	Pumped flow	92,770 (17.6 mi)	0	Avoid potential water quality issues in the Trinity River	High pipeline and operational costs
						Joe Pool Lake permitting/storage issues
						Requires an intake facility at Joe Pool Lake
B	Joe Pool Lake to Bachman WTP	Open channel / Pumped flow	30,192 (5.7 mi)	62,294 (11.8 mi)	Potential cost benefit from reduced pipeline length	Joe Pool Lake permitting/storage issues
						Requires an intake facility on Mountain Creek
C	Joe Pool Lake to Bachman WTP	Open channel /Pumped flow	20,693 (3.9 mi)	75,192 (14.2 mi)	Potential cost benefit from reduced pipeline length	Potential water quality degradation due to Trinity River
						Joe Pool Lake permitting/storage issues
						Requires an intake facility on the Trinity River
D	Third Pipeline to Bachman WTP - Cedar Hill Alternative	Pumped flow	160,075 (30.3 mi)	0	Avoid potential water quality issues in the Trinity River	Highest pipeline and operational costs
					Avoid Joe Pool Lake permitting/storage issues	Permitting issues - pipeline corridor passes through federal & protected park lands
					Eliminate need for additional intake facility	Difficulty of obtaining easements because of urban setting
E	Third Pipeline to Bachman WTP - SH 360 Alternative	Pumped flow	146,669 (27.8 mi)	0	Avoid potential water quality issues in the Trinity River	Higher pipeline and operational costs
					Avoid Joe Pool Lake permitting/storage issues	
					Eliminate need for additional intake facility	
					Eliminate permitting issues associated with Alternative D	

Scenario 1: Transmission to Bachman WTP
Alternative Route A

Bachman Lake

Bachman WTP

Estelle Creek

Bear Creek

Delaware Creek

Elm Fork Trinity River

Trinity River

Vilbig Lakes

West Fork Trinity River

West Dallas Housing Project Lake

Bluebonnet Lakes

Texaco Lake

Coombs Creek

Cottonwood Creek

Mountain Creek Lake

Crow Creek

Kirby Creek

Artesian Creek

Mountain Creek

O'Guinn Creek

Fivemile Creek

Fish Creek

JOE POOL LAKE

Tenmile Creek

Mauk Branch

Legend

- Streets
- Rivers and Streams
- Alternative Route A

N W E S

TARRANT REGIONAL WATER DISTRICT

dallas water utilities
city of dallas

CDM/KBR

0 2,500 5,000 Feet

Figure 8-2

Scenario 1: Transmission to Bachman WTP
Alternative Route B

Bachman Lake
Bachman WTP
Estelle Creek
Elm Fork Trinity River
Delaware Creek
Trinity River
Vilbig Lakes
West Fork Trinity River
Bear Creek
Johnson Creek
Bluebonnet Lakes
Texaco Lake
Coombs Creek
Cottonwood Creek
Mountain Creek Lake
Kirby Creek
Artesian Creek
O'Guinn Creek
Fivemile Creek
Crow Creek
Mountain Creek
Fish Creek
JOE POOL LAKE

Legend

- Streets
- Rivers and Streams

Alternative Route B

- Open Channel Flow
- Pumped Flow

N W E S

Tarrant Regional Water District
dallas water utilities
city of dallas

CDM/KBR

0 2,500 5,000 Feet

Figure 8-3

Scenario 1: Transmission to Bachman WTP
Alternative Route C

Las Colinas Reservoir Number 7
Estelle Creek
Joes Creek
Bachman Lake
Bachman WTP
Elm Fork Trinity River
Delaware Creek
Trinity River
Vilbig Lakes
West Fork Trinity River
Bear Creek
West Dallas Housing Project Lake
Bluebonnet Lakes
Texaco Lake
Cottonwood Creek
Coombs Creek
Mountain Creek Lake
Kirby Creek
Artesian Creek
Mountain Creek
O'Guinn Creek
Fivemile Creek
Crow Creek
Fish Creek
Mauk Branch
JOE POOL LAKE
Tenmile Creek

Legend

- Streets
- Rivers and Streams

Alternative Route C

- Open Channel Flow
- Pumped Flow

N
W
E
S

Tarrant Regional Water District
dallas water utilities
city of dallas
CDM/KBR

0 2,500 5,000 Feet

Figure 8-4

Scenario 1: Transmission to Bachman WTP
Alternative Route D

Lake Carolyn
Las Colinas Reservoir Number 7
Joes Creek
Bachman Lake
Bachman WTP
Elm Fork Trinity River
Delaware Creek
Trinity River
Vilbig Lakes
West Dallas Housing Project Lake
West Fork Trinity River
Bluebonnet Lakes
Texaco Lake
Coombs Creek
Cottonwood Creek
Mountain Creek Lake
Johnson Creek
Kirby Creek
O'Guinn Creek
Crow Creek
Artesian Creek
Fivemile Creek
Fish Creek
Mountain Creek
Mauk Branch
Woody Branch
Lynn Creek
JOE POOL LAKE
John Penn Branch
Bowman Branch
Stewart Branch
Tenmile Creek
Baggett Branch
Bentle Branch
Bee Branch
Heath Creek
Walnut Creek
Magic Valley Ranch Lake
Little Creek
Bear Creek
Low Branch
Red Oak Creek
Hollings Branch
Bedford Branch
North Prong Creek
Gifford-Hill Lake
Soil Conservation Service Site 11 Reservoir
Reece Branch
Soap Creek
Soil Conservation Service Site 1 Reservoir
Soil Conservation Service Site 10 Reservoir

0 4,000 8,000 Feet

Legend

- Streets
- Rivers and Streams
- Alternative Route D
- TRWD RC/CC Pipelines

Figure 8-5

CDM/KBR

Scenario 1: Transmission to Bachman WTP
Alternative Route E

Lake Carolyn
Lake Carolyn
Joes Creek
Bachman Lake
Bachman WTP
Elm Fork Trinity River
Delaware Creek
Trinity River
Vilbig Lakes
West Dallas Housing Project Lake
Bluebonnet Lakes
West Fork Trinity River
Texaco Lake
Johnson Creek
Coombs Creek
Cottonwood Creek
Mountain Creek Lake
O'Gunn Creek
Fivemile Creek
Kirby Creek
Crow Creek
Artesian Creek
Fish Creek
Mountain Creek
Mauk Branch
Woody Branch
Lynn Creek
Bowman Branch
JOE POOL LAKE
John Penn Branch
Stewart Branch
Tenmile Creek
Baggett Branch
Bentle Branch
Bee Branch
Heath Creek
Walnut Creek
Magic Valley Ranch Lake
Little Creek
Low Branch
Hollings Branch
Bedford Branch
North Prong Creek
Soap Creek
Gifford-Hill Lake
Soil Conservation Service Site 11 Reservoir
Soil Conservation Service Site 1 Reservoir

0 4,000 8,000 Feet

Legend

- Streets
- Rivers and Streams
- Alternative Route E
- TRWD RC/CC Pipelines

Tarrant Regional Water District
dallas water utilities
city of dallas
CDM/KBR

Figure 8-6

8.3.2 Conveyance Cost Analysis

The alternative route in Scenario 1 with the combination of highest probable cost and lowest probably disadvantage was selected for the conveyance cost analysis. This selection does not indicate a preference for this route but does provide the decision-maker with a result that bounds the possible cost implications. Alternative route E was selected over the other highest probable cost alternative (route D) because it does not pass through federal and protected park lands on the east of Joe Pool Lake and because it enables gravity transmission to Bachman WTP, as opposed to the higher ground elevations of Alternative D that would lead to more complicated transmission hydraulics.

Alternative route E begins at the southwest corner of Joe Pool Lake at an approximate ground elevation of 600 feet. Using a ground storage tank (GST) to serve as a balancing reservoir for the pipeline, which drops approximately 190-feet from the location of the GST to the headworks of Bachman WTP, a 78-inch pipeline enables gravity flow for the entire length of the route at a design flow of 128 MGD without the need of a booster pump station. Because alternative route E does not utilize a pump station, energy costs do not factor into the life-cycle cost analysis.

Based on the capital and life-cycle cost assumptions described in Sections 1 and 3, the opinion of capital cost for alternative route E in Scenario 1 is $171,132,000 and the Present Value of the 50-year life-cycle cost is $258,729,000.

8.3.3 Bachman WTP

In addition to the conveyance system to Bachman WTP, Scenario 1 includes treatment of raw water from Lake Palestine that has blended with Cedar Creek Reservoir water. The raw water quality for this scenario is as follows:

- Alkalinity 60 mg/L
- Hardness 5 0 mg/L
- TOC 7.0 mg/L
- TDS 132 mg/L
- Bromide 0.09 – 0.12 mg/L
- Iron 81 ug/L
- Manganese 97 ug/L

The treatment process at Bachman WTP, with projected modifications to include biological filtration, would sufficiently treat this raw water supply to meet desired water quality goals. However, due to elevated levels of TOC and manganese, additional ferric sulfate would be required to meet TOC reduction targets and

additional ozone would be required for manganese oxidation and potentially increased demand from higher organic content in the water.

Currently planned improvements to the Bachman WTP include modifications for enhanced coagulation. These improvements include additional chemical storage and feed facilities that would be sufficient for treating the higher levels of TOC associated with Scenario 1.

To facilitate oxidation of the increased levels of manganese in the Lake Palestine/Cedar Creek Reservoir blend, approximately 200 lb/day of ozone would be required. This is a small percentage of the current overall ozone capacity at the plant and existing ozone generators would likely have sufficient capacity to meet this additional requirement. Ozone generation capacity could also be increased by decreasing the ozone in oxygen concentration during periods of high flow and high ozone demand.

Because no additional facilities would be required at the Bachman WTP, the estimated capital cost is zero. The probable operating cost for Scenario 1 (chemicals and power for ozone production) is $60 per MGal treated. This evaluation assumes that the existing Bachman WTP can meet the 102 mgd capacity requirement for Lake Palestine water. However, it does not include the costs for expanding the City's overall treatment plant capacity by 102 mgd. This would likely be done by expanding the Elm Fork WTP by 102 mgd. The cost for expanding such an existing facility, if room for expansion is available, would be comparable to a new plant of the same size, approximately $200,000,000.

8.4 Scenario 2 – Southeast WTP

In this analysis, Scenario 2 correlates to the cost and water quality analysis found in Project Conveyance Alternative 1 (independent system with DWU connection to the SEWTP). Costs from this scenario are additive to Alternative 1 costs and the raw water used in this scenario (Lake Palestine only) is the same as that in Alternative 1. Scenario 2 includes treatment of raw water from Lake Palestine at the new Southeast WTP. The raw water quality for this scenario is as follows:

- Alkalinity 38 mg/L
- Hardness 48 mg/L
- TOC 8.5 mg/L
- TDS 138 mg/L
- Bromide 0.12 mg/L
- Iron 110 ug/L
- Manganese 250 ug/L

The selected treatment process (see Section 8.2.2) would sufficiently treat this raw water supply to meet target water quality goals. However, due to low alkalinity and elevated levels of TOC and manganese, the water will be more difficult to treat than the raw water from Scenario 1, and will require greater quantities of treatment chemicals. Additional ferric sulfate would be required to meet TOC reduction targets and additional ozone would be required for manganese oxidation and potentially increased demand from higher organic content in the water.

The probable construction cost for a conventional water treatment plant with ozonation facilities and onsite sludge lagoons is approximately $2.00 per gallon. This cost is based on recent (2008) construction cost bids for similar facilities. The construction cost of a new 102 mgd water treatment plant would be approximately $204 million. To account for additional ozonation facilities and chemical storage and feed facilities, this cost was increased by 5%. Therefore, the probable capital cost for the new 102 mgd Southeast WTP would be approximately $215,000,000. The probable operating cost (chemicals and power for ozone production) is $66 per MGal treated.

8.5 Scenario 3 – WTP at Joe Pool Lake

In this analysis, Scenario 3 correlates to the cost and water quality analysis found in Project Conveyance Alternative 3 (Interconnected Third Pipeline). Costs from this scenario are additive to Alternative 3 costs and the raw water used in this scenario is the same as that in Alternative 3, a blend of Lake Palestine and Cedar Creek Reservoir water. Scenario 3 includes treatment of raw water from Lake Palestine that has blended with Cedar Creek Reservoir water. It was assumed that raw water would be pulled off prior to discharge into Joe Pool Lake and treated at a new water treatment plant near Joe Pool Lake. The raw water quality for this scenario is as follows:

- Alkalinity 60 mg/L
- Hardness 50 mg/L
- TOC 7.0 mg/L
- TDS 132 mg/L
- Bromide 0.09 – 0.12 mg/L
- Iron 81 ug/L
- Manganese 97 ug/L

The selected treatment process (see Section 8.2.2) would sufficiently treat this raw water supply to meet target water quality goals. The raw water quality is the same as Scenario 1 and would require the same treatment process and treatment requirements. Therefore, the probable construction cost of a new 102 mgd water treatment plant near Joe Pool Lake would be approximately $204 million, not

including the potential cost of purchasing a treatment plant site. The probable operating costs (chemicals and power for ozone production) are $60 per MGal treated.

8.6 Mountain Creek Lake Considerations

8.6.1 Mountain Creek Lake Overview

Mountain Creek Lake was built as a cooling reservoir for a power plant originally constructed in 1938. The reservoir is still used for cooling purposes at the Mountain Creek Generating Station. This power plant is operated by Exelon Corporation according to the Exelon web site[2]. The annual use reports reviewed indicate that this plant may divert between about 120 cfs and in excess of 900 cfs for cooling and other industrial purposes. The TCEQ tabulation of water rights and documents available of record from the TCEQ do not indicate any other CA or permit holder for water from Mountain Lake. TCEQ staff confirmed that it is unlikely another CA or permit holder exists, but that there can be infrequent omissions in the TCEQ database.

Technical Data on Mountain Creek Lake

Water Right – Certificate of Adjudication 08-3408

Water Right Owner – ExTex LaPorte

Reservoir Owner – ExTex LaPorte

Stream – Mountain Creek, tributary of the Trinity River

County – Dallas County

Conservation Storage Capacity – 22,840 acre-feet

Maximum Diversion – "Owner is authorized to divert and consumptively use not to exceed 6400 acre-feet of water per annum from the aforesaid reservoir for industrial purposes."

Maximum Diversion Rate – The maximum combined rate of diversion specified in Certificate of Adjudication 08-3408, Paragraph 3.B. has been marked out in the copy received from TCEQ. No maximum diversion rate is specified in the tabulation of water rights maintained by TCEQ.

Priority Date: March 12, 1929

Environmental Flow Requirements – none indicated in materials reviewed

As with the other reservoirs we have studied on the Trinity River, the water right for Mountain Creek Reservoir does not expressly authorize surface water to be stored in the reservoir from sources outside the Trinity River basin, nor does the water right preclude such storage. The CA also did not include special provisions,

[2] ExTex LaPorte and Exelon appear to be related entities.

such as environmental flow requirements or conservation requirements for wholesale water users that would otherwise affect storage or transmission of water from outside the Trinity River basin in or through Mountain Creek Reservoir.

We note that the Mountain Creek Generating Station pumps a large amount of water from Mountain Creek Reservoir for cooling and other industrial purposes. This may cause the reservoir level to fluctuate, affect the temperature of the water in the reservoir, and otherwise affect water passing through the reservoir. The CA for the reservoir is senior to that of the Lake Palestine transfer (and most other water rights in the area), and so the transfer must be implemented so as to not affect these senior rights. The CA allows the holder to divert and consumptively use only 6,400 acre-feet of water annually. According to the annual use reports, the generating station diverted 491,230.81 acre-feet from Mountain Creek Lake in 2004, and consumed 1084.456 acre-feet. These figures are consistent with or lower than past years. Our interpretation of the diversion restriction imposed by the CA is that the power plant is currently exceeding its allowable diversions, but that these large diversions may not detrimentally affect the amount of water available to other water right holders. Any subsequent use of the reservoir by Dallas Water Utilities would need to take into account the generating station's permitted diversions rather than its current actual diversions.

See **Figure 8-7**, prepared by the City of Dallas, depicting the general location of Mountain Creek Lake and its watershed.

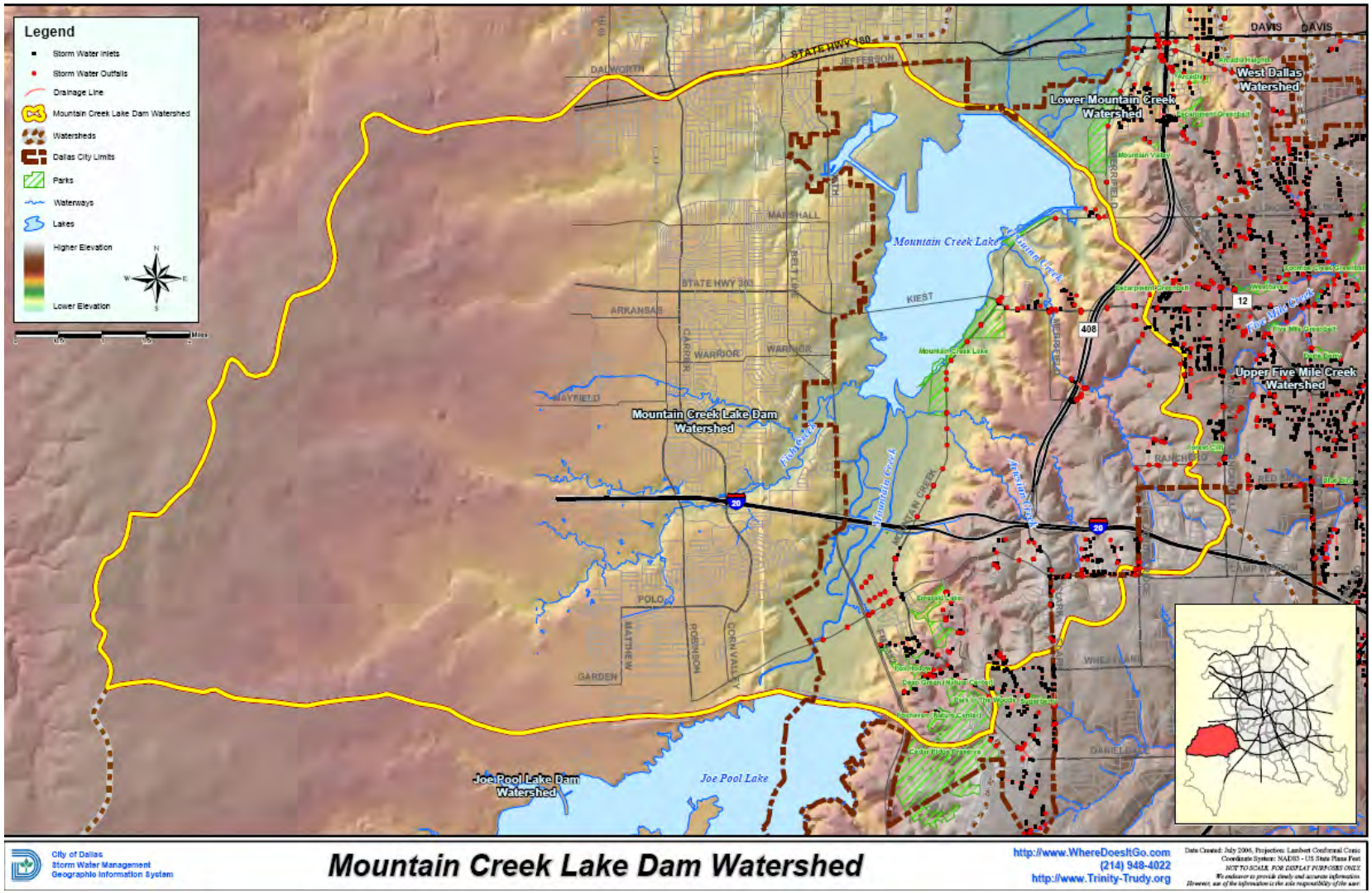


Figure 8-7
Mountain Creek Lake Dam Watershed

8.6.2 Mountain Creek Water Quality

Under one of the alternative routes in Scenario 1 discussed above, 102 mgd of the interconnected TRWD/DWU water would be routed from Joe Pool Lake through Mountain Creek Lake to the Bachman WTP. The Texas Commission on Environmental Quality (TCEQ) has identified water quality concerns in Mountain Creek Lake. The following provides a summary of the water quality concerns associated with this water body and evaluates their importance with regards to the water routing proposal.

Existing Water Quality

The following sections summarize what is known regarding existing water quality in Joe Pool and Mountain Creek Lakes.

Joe Pool Lake – Joe Pool Lake is a 7,470 acre reservoir that is protected for the following beneficial uses: Aquatic life, contact recreation, general, fish consumption and public water supply. Reservoir water quality is regularly assessed by TCEQ every two years; the latest draft assessment was completed in March 2008 (TCEQ 2008). This assessment reported that water quality in the reservoir is good with all assessed beneficial uses fully supported – including the public water supply use. The 2008 findings are consistent with assessments completed in previous years.

Mountain Creek Lake – This lake is a 2,710 acre reservoir that is protected for the following beneficial uses: Aquatic life, contact recreation, general, fish consumption and public water supply. In contrast to Joe Pool Lake, this reservoir has water quality concerns – but only as applicable to the protection of the fish consumption use (TCEQ 2008). No concerns have been identified for other beneficial uses, e.g., public water supply (TCEQ 2008).

The fish consumption advisory was issued on April 25, 1996 as result of lake studies conducted in 1994-1995 by the U.S. Geological Survey (see Van Metre et al. 2003). These studies showed elevated concentrations of PCBs, chlordane, heptachlor epoxide, and DDT (and its byproducts DDD and DDE), in sediments and fish tissue that exceeded Texas Department of Health (TDH) guidelines for the consumption of fish. Sources of these contaminants date back to activities occurring along and near the lake at the Naval Air Station Dallas and the Naval Weapons Industrial Reserve Plant, primarily from 1941 to 1974.

Changes in discharge practices and implementation of state and federal environmental laws and regulations since the 1970s have resulted in a gradual improvement in sediment quality. For example, Van Metre et al. (2003) showed substantial differences in sediment quality with sediment depth in the lake bottom. Older, deeper sediments had substantially higher levels of contaminants than newer, surficial sediments. This change demonstrates that contaminant control and

remediation activities are resulting in a greatly reduced load of contaminants to the reservoir.

Van Metre et al. (2003) identified a number of concerns regarding contaminants in fish tissue including PCBs and various organochlorine pesticides. For metals, only selenium was identified as a concern, but no concerns were identified for other organic chemicals such as polycyclic aromatic hydrocarbons (PAHs) and volatile organic compounds (VOCs).

Ultimately, the outcome from the findings of this study was the listing of Mountain Creek Lake as an impaired waterbody requiring a Total Maximum Daily Load (TMDL) to address impairment of the fish consumption use. This listing was based solely on the fish tissue data and resulting fish consumption advisory for the following contaminants: DDT, DDD, DDE, chlordane, dieldrin, PCBs and heptachlor epoxide. The listing was not based on the finding of any contaminants at levels of concern in the water column.

In June 2001, the Environmental Protection Agency approved a TCEQ adopted TMDL established, in part, to address the fish consumption impairment in Mountain Creek Lake (TCEQ, 2000). Subsequently, the TCEQ adopted a plan to implement the EPA-approved TMDL (TCEQ, 2001). This plan relies on the continued remediation of contaminant sources at source sites (e.g., Naval Air Station) to prevent any additional loadings to the lake, e.g., through the runoff of stormwater, and the passage of time to achieve compliance. As correctly noted in the TMDL, source control is critical so that no new loadings to the waterbody occur, but a key means for achieving success is to allow time for natural attenuation processes to occur.

Natural attenuation relies on the natural process of sedimentation to the lake to deposit clean sediment over contaminated sediment. Clean bottom sediments prevent contaminants from being consumed by invertebrates which are in turn consumed by fish resulting in bioaccumulation in fish tissue. Over time (many years) the result of natural attenuation will be a gradual reduction in fish tissue concentrations. The time to success will be improved the more quickly the sources of contaminants in the watershed are eliminated.

Efforts to reduce contaminant loadings have been ongoing for some time. TDH (2002) provides evidence that this process is gradually improving water quality. They note that in 1995 67 of 68 fish tissues samples contained the PCB congener Aroclor 1260. Of 10 samples collected in 2000 and 2001 Aroclor 1260 was detected in only one fish sample. Although this result suggests that water quality management efforts are resulting in water quality improvements, TDH wanted to collect more data before determining whether PCB levels were low enough to support removal of the fish consumption advisory (at least for PCBs). As of this date, the fish consumption advisory remains in place.

Water Quality Discussion and Recommendations

Based on the review of Joe Pool Lake and Mountain Creek Lake water quality data, it is unlikely that routing water through Mountain Creek Lake to Bachman WTP will result in any drinking water quality concerns. This finding is based on the following:

- Water quality in the source water (Joe Pool Lake plus Lake Palestine, or Lake Palestine/Cedar Creek Reservoir blends) is good and the blended interconnected supplies would be acceptable for drinking water uses as previously discussed in Section 5;

- TCEQ has repeatedly made a regulatory finding that water quality in Mountain Creek Lake fully supports the Public Water Supply beneficial use.

- Water quality concerns in Mountain Creek Lake are limited to sediment and fish tissue – not the water itself. These concerns are also primarily associated with the Cottonwood Bay portion of the reservoir and not the main lake.

- A TMDL has been established which is aggressively addressing contaminant loadings to the reservoir.

- Evidence exists (TDH 2002) that contamination mitigation efforts are resulting in less contamination in fish tissue.

While these findings suggest that routing water through the reservoir is a viable option with regards to water quality, the following recommendations should be considered if that option is pursued:

- Because a TMDL exists on the reservoir, this option should be discussed with TCEQ to identify any concerns that they may have. Discharging water from Joe Pool Lake to Mountain Creek Reservoir changes the dynamics of the reservoir and may need to be factored into TCEQ's TMDL implementation program.

- The TCEQ periodically assesses water quality in Mountain Creek Lake as part of the state biannual waterbody assessment process. If this reservoir becomes a source location for the Bachman WTP, the treatment facility may want to conduct additional source water sampling to supplement TCEQ's monitoring program.

8.7 Summary and Conclusions

Table 8-3
DWU Additional Treatment and Water Transmission Facilities
Summary Conclusions

Results	DWU Scenario		
	1 Bachman WTP	**2 Southeast WTP**	**3 WTP at Joe Pool**
Conveyance Capital Cost[(1)]	$171,132,000	n/a	n/a
Treatment Infrastructure Capital Cost	No Cost at Bachman WTP + Elm Fork Expansion (~$200,000,000)	$215,000,000	$204,000,000
Treatment Op. Cost (per MGal Treated)	$60	$66	$60
Present Value of 50-year Life-Cycle Cost	$782,604,000[(2)]	$572,321,000	$554,872,000
Notes	Costs for expanding DWU's overall treatment plant capacity by 102 mgd (by expanding the Elm Fork WTP if room for expansion is available) would be comparable to a new plant of the same size	Cost for conveyance is included in Project Conveyance Alternative costs	Cost for conveyance is included in Project Conveyance Alternative costs

Note (1): Distribution system costs (downstream of the WTP) are not included.

Note (2): The replacement of 102 mgd capacity at Elm Fork WTP is included in this figure. If this cost is excluded, the Present Value of the 50-year life-cycle cost is $335,572,000.

Modifications to Bachman WTP treatment process:

- Biological filtration (currently being implemented);
- Additional ferric sulfate storage and feed facilities to meet desired TOC reduction (current enhanced coagulation improvements should meet these requirements); and
- Additional ozone generation capacity (approximately 200 lb/day) for manganese oxidation (existing plant ozonation facilities should be capable of providing this increased ozone requirement)

Proposed Southeast WTP

- Due to low alkalinity and elevated levels of TOC and manganese, the water would be more difficult to treat than the raw water from Scenario 1 (at Bachman WTP);
- Additional ferric sulfate addition would be required to meet desired TOC reduction; and

- Additional ozone would be required for manganese oxidation and due to increased demand from higher organic content in the water.

Proposed Joe Pool Lake WTP: raw water quality would be the same as that for Scenario 1 (at Bachman WTP) and would require the same treatment process and treatment requirements.

Mountain Creek Lake

The Mountain Creek Lake water right does not expressly authorize surface water to be stored in the reservoir from sources outside the Trinity River basin, nor does the water right preclude such storage. The Certificate of Adjudication also does not include special provisions, such as environmental flow requirements or conservation requirements for wholesale water users that would otherwise affect storage or transmission of water from outside the Trinity River basin in or through Mountain Creek Lake.

Based on the review of Joe Pool Lake, Lake Palestine, Cedar Creek Reservoir and Mountain Creek Lake water quality data, it is unlikely that routing water through Mountain Creek Lake to Bachman WTP will result in any significant drinking water quality concerns. These findings suggest that the option to route water through Mountain Creek Lake is a viable option with regards to drinking water quality.

Section 9
Preliminary Findings and Recommendations

9.1 Preliminary Findings

The purpose of this initial Project Viability Assessment and Business Case Evaluation was to 1) identify any "fatal flaws" to developing an integrated raw water transmission system; and 2) compare the separate, independently adopted water strategies of both TRWD and DWU with integrated raw water delivery system alternatives in terms of their life-cycle cost implications, water quality and treatment implications, and permitting and environmental issues. Six tasks were completed as part of this initial Project Viability Assessment and Business Case Evaluation.

1. Integrated system operations analysis;
2. Capital and life-cycle cost analysis;
3. Facility siting constraints assessment;
4. Environmental water quality review;
5. Consideration of water treatment impacts; and
6. Permitting and regulatory review.

At the outset of this initial Project Viability Assessment and Business Case Evaluation, the project team recognized that separate, sound water management strategies are already in place for both DWU and TRWD and that any integrated, joint-agency approach would need to meet several key objectives to complement or replace existing plans:

- An integrated raw water transmission system alternative must enhance the redundancy, flexibility, and demand risk management of the existing water supply systems;
- An interconnected plan must make sufficient water supply available to meet demands where and when needed, under a full range of historical hydrological conditions;
- An integrated raw water transmission system alternative must reduce capital and life-cycle costs, while not contributing to unmitigated treatment or distribution costs for DWU or TRWD customers; and

- All scenarios must fully consider societal, environmental, and regulatory complexities

With these key objectives guiding the way, four project conveyance alternatives were developed through a progressive screening approach to evaluate combinations of conveyance infrastructure and interconnections. Two Baseline Alternatives (independent water strategies) and the two most promising Interconnection Alternatives (integrated delivery systems) were then selected (as described in **Table 1-1** and repeated below for the reader's convenience). Key findings from the six tasks as they relate to the objectives listed above are here presented based on the analysis of these four project conveyance alternatives.

Alternative	Description
1 (Baseline)	Independent Systems: TRWD's East Texas Third Pipeline and DWU's connection of Lake Palestine to the proposed Southeast Water Treatment Plant
2 (Baseline)	Independent Systems: TRWD's East Texas Third Pipeline and DWU's connection of Lake Palestine to Joe Pool Lake
3 (Interconnection)	Integrated System: Interconnected Third Pipeline (upsized as compared to the baseline condition) with connection of Lake Palestine to Cedar Creek Reservoir and delivery to DWU at Joe Pool Lake and TRWD's customers through the Third Pipeline
4 (Interconnection)	Integrated System: Interconnected "Southern Pipeline" - Lake Palestine delivered to the Lake Benbrook pipeline via a pipeline route to the south of the TRWD Third Pipeline route. Delivery to DWU at Joe Pool Lake and TRWD's customers through connections to the existing system and the Lake Benbrook pipeline.

9.1.1 Conclusions from Integrated Operations Analysis

The purpose of this analysis was to identify opportunities for benefits, or potential disadvantages, to both TRWD and DWU through integrated operations of the raw water transmission systems from Lake Palestine, Richland-Chambers Reservoir, and Cedar Creek Reservoir. This comparison of Baseline Alternatives 1 and 2 with Interconnection Alternatives 3 and 4 (see Table 1-1) was driven by a system operations model and the team's water resource planning experience. This model was formulated as a decision-support system that permitted the user to create an array of scenarios that help answer a series of primary and secondary questions, formulated jointly by the project participants during workshops:

In this context, we can conclude the following regarding operating costs, water sharing and timing, redundancy, flexibility, and regional cooperation:

9.1.2 Operating Costs

The integrated operations modeling shows that operating costs within the bounded system are lower in interconnected alternatives as compared to baseline alternatives. This opportunity for operational cost savings is more pronounced in the near term and decreases over time as the difference between interconnected and independent

operations is minimized. This near-term savings is attributed to the fact that the full amount of DWU water supply from Lake Palestine is not required immediately. (DWU access to the TRWD supply system could extend the need to connect the Lake Palestine supply to each system.)

9.1.3 Water Sharing and Timing

The integrated operations modeling found that there is opportunity to make extra water available to water user groups via an interconnected system. The analysis suggests that even under drought conditions in 2020, approximately 80 additional mgd could be available. This result is based on three modeling protocols: 1) water availability is limited by existing TRWD permits (for Richland-Chambers, Cedar Creek, and the planned wetlands); 2) DWU demand is equal to the contracted amount in Lake Palestine (102 mgd); and 3) conveyance is limited by the capacity of existing and planned TRWD conveyance facilities.

This result also confirms that Lake Palestine supply will be required prior to 2020 if the DWU demand reaches 102 mgd (though not all of it will be required immediately and dependence upon it as a source could conceivably be phased). Additions to conveyance capacity could be phased through 2030. TRWD requires water supply in addition to sources already included in the model, such as the constructed wetlands, between 2030 and 2040 (based on existing permit constraints and projected demands).

Interconnection also provides the opportunity for TRWD to use the 102 mgd from Lake Palestine. This water sharing may be useful in an emergency situation or in a localized drought condition that causes deficit in the TRWD system while excess is available to DWU. This opportunity to share water between the two water providers is also a method of demand risk management to mitigate the effects of unforeseen demand growth patterns in the TRWD or DWU systems.

By the year 2030, any configuration of the system becomes supply limited, and reliability predictions during severe droughts would be roughly equivalent among configurations. However, during normal hydrologic periods, extra supply is available through 2060 in an interconnected system, though TRWD may have conveyance limitations to accessing the water. The analysis also indicates that the TRWD system can support sustained withdrawals above the current permitted levels. In other words, supply is limited by the permitted amounts, not water availability.

With an interconnected system, any additional water above projected demands would conceivably be available to any water user group, provided that conveyance capacity would be adequate. With separate systems, this water would not be available to DWU and TRWD and its customers would not benefit from potential sales or trades of water above projected TRWD customer demands. With an interconnected system, there is also the possibility of bringing other, currently independent sources (such as DWU reuse water) and new water supply sources (Toledo Bend, Oklahoma, etc.) into the interconnected system to enhance the potential for water sharing.

To satisfy the DWU demands as they are represented in the model, the full yield of Lake Palestine (102 mgd) is needed immediately if the two systems remain separate. If conveyance systems are interconnected, use of Lake Palestine could ramp up gradually (assuming TRWD water supply in excess of projected demands could help satisfy DWU demand). This offers significant benefits with respect to phased infrastructure that are not available with separate systems.

9.1.4 Redundancy

Operational redundancy is a "belt and suspenders" approach to risk management that enables the water supplier to select from multiple supply sources in times of emergency, drought, failure, etc. An interconnected supply system therefore provides more opportunity for supply and failure risk management.

In the event of a pipe failure or power outage, an integrated transmission system has more alternative flow pathways and connections to multiple water and power sources. These additional connections lower risk to the water provider. The impacts of climatic variations are also lessened because of the diversification of reservoir locations. An interconnected system "casts a wider net" to reservoirs in different watersheds that will potentially experience drought in different times or levels of severity. Also, access to additional sources that may not be fully utilized adds supply redundancy to the system.

9.1.5 Operational Flexibility

Under prevailing ("normal") hydrologic conditions when the modeled system is not supply-limited, an interconnected system offers more operational flexibility than separate sources, since multiple flow pathways could be used to transport water. Such flexibility could be used to capitalize on advantageous opportunities for blending of sources, pump cycling schedules, system maintenance and energy management. One potential disadvantage of operations in an integrated system is the potential for increased operational complexity and the attendant new systems and protocols that must be developed to manage such a system.

The interconnected system also provides flexibility in terms of water availability. Extra supply is available through 2060 in an interconnected system and the analysis indicates that the TRWD system can support sustained withdrawals above the current permitted levels. This ability to overdraft supply sources provides flexibility to system operations, the potential for lower operating costs, and risk mitigation.

The National Water Research Institute in its November 2007 white paper entitled "Water 2010: A 'Near Sighted' Program of Water Resource Management Improvements for the Western United States" recommended system interties as its number one action item for state and local policymakers. NWRI concluded that "System interties increase the flexibility of system operators to respond to weather events, natural disasters, contaminations incidents, or the need to take water treatment or conveyance facilities temporarily off-line for repair or

refurbishment……many interconnections can be planned and constructed within just a few years and at a relatively low cost."

9.1.6 Regional Cooperation

TRWD and DWU have a long history of cooperation in water supply planning, including the Texas Water Development Board regional water planning efforts initiated by the 1997 passage of Senate Bill 1 in the 75th session of the Texas Legislature. This on-going cooperation has led to this study and the potential for raw water transmission system interconnection. The interconnection of the two systems provides opportunities for benefit to both agencies by laying the groundwork for interconnecting future water supply sources (Toledo Bend, Oklahoma, etc.), increasing the portfolio of water supply options, reducing the costs of right-of-way through earlier acquisition, providing financing risk management, and compliance with TWDB planning guidelines.

The groundwork for regional cooperation in accessing future water supply options has already been laid; integrated water supply infrastructure provides additional opportunity for cost savings and will facilitate future inter-local agreements. By interconnecting the transmission system, each agency also effectively increases its portfolio of water supply options through the potential to share water and infrastructure.

Escalating costs for right-of-way acquisition (and urbanization) also point to the benefits of securing transmission routes early. This early acquisition presents an opportunity to acquire sufficient right-of-way for future joint water supplies. TRWD has recently experienced the following average costs for securing easements for several large diameter transmission system projects, costs which raise the issue of expedited acquisition of right-of-way for this and other future joint projects:

- Real estate classified as rural - $15,415 per acre.
- Real estate classified as undeveloped, planned - $33,792 per acre.
- Real estate classified as developed - $71,247 per acre.

Escalation in the cost of materials and ever increasing pressure on the financing market also point to the benefits of interconnection. Economies of scale and the ability to leverage the joint financing capacity of both agencies are benefits in integration.

Along with the other opportunities for benefits through integration, this regional cooperation is in compliance with TWDB guidelines for water supply planning. These guidelines and the TWDB planning process require this cooperation.

9.1.7 Summary of Integrated Operations Conclusions

From an operational perspective, the analysis supports further investigation of interconnected conveyance alternatives. Unlike separate systems, an interconnected system that routes Lake Palestine through the planned TRWD system offers reduced operating costs, cost sharing, savings due to infrastructure phasing, opportunities for water sharing, the potential for increased overall system yield and supply reliability, redundancy, and operational flexibility with respect to infrastructure scheduling and daily operations.

These results indicate a broad range of potential benefits that could be realized with an interconnected system as opposed to separate systems. Subsequent sections of this report address other factors relevant to interconnections, such as water quality, treatment requirements, environmental impacts, etc. Subsequent phases of work will establish operating protocols and cost agreements for shared conveyance and shared supply, and will address permitting needs.

9.1.8 Lifecycle Cost Analysis

Results from this screening level cost analysis show that there are opportunities for significant cost savings through integrated conveyance system alternatives to deliver DWU and TRWD supplies. Delivering water through an Interconnected Third Pipeline has potential Present Value, 50-year lifecycle cost savings between approximately $220,000,000 and $540,000,000.

The Interconnected Southern Pipeline alternative has potential Present Value, 50-year life-cycle cost savings when compared to Alternative 2 (baseline with delivery to Joe Pool) but increased cost when compared to Alternative 1 (baseline with delivery to SE WTP). However, because the Interconnected Southern Pipeline delivers water to Joe Pool Lake and not the SE WTP, the most direct comparison is between the Interconnected Southern Pipeline and Alternative 2, which results in an approximate $36,600,000 savings. Subsequent phases of this feasibility assessment will consider other potential benefits from the Southern Pipeline, such as supply risk reduction and right-of-way acquisition for future supplies. Escalating costs raise the issue of expedited acquisition of right-of-way (e.g. in the Southern Pipeline route) to manage the availability and cost of acquisition for this and future water supplies from East Texas. Also, phasing could also result in significant reduction of costs associated with the Interconnected Southern Pipeline due to the potential to defer development of transmission facilities required to deliver water to Lake Benbrook.

9.1.9 Environmental Water Quality and Water Treatment

Integrating Lake Palestine water into the DWU and TRWD raw water supply systems will have a low to moderate impact on environmental water quality and treatment at the receiving reservoirs and at the water treatment plants. The major impacts of the Lake Palestine water on water treatment relate to its low alkalinity, high TOC, and high manganese concentrations. The importation of Lake Palestine water will result in higher nutrient levels at the studied receiving reservoirs but will not likely to lead

to impacts that impair the designated uses of the water bodies. Additional studies will help predict the complex kinetic relationships between nutrients and chlorophyll-a, particularly for those reservoirs where additional water management strategies include supply augmentation with reuse water.

9.1.10 Ellis and Johnson Counties

The Region C Four County Study (by Freese & Nichols, Inc.) concluded that population and demand projections are exceeding those included in the 2006 Region C water plan. Both TRWD and DWU have existing and projected wholesale customers in Ellis and Johnson Counties to be served by the integrated conveyance systems analyzed in this study. Further development of the raw water transmission integration alternatives will allow TRWD and DWU to consider how these demands can be jointly met in terms of supply, infrastructure and contractual agreements, including advancement of the Trinity River Authority Ellis County Water Supply Project recommended in the Region C Water Plan.

9.1.11 DWU Additional Treatment and Transmission Facilities

This task considered additional cost and treatment implications for transmission of raw water to DWU treatment and distribution system facilities from project conveyance Alternatives 1 and 3, which respectively represent the independent and interconnected raw water transmission system. These additional treatment and water transmission facilities that may be required for a fully functional integrated strategy for DWU were beyond the initial study boundary; therefore, costs implications in this section are additive to the project conveyance alternative costs. These costs do not include distribution system improvements needed downstream of the water treatment plants.

Table 9-1
DWU Additional Treatment and Transmission Facilities

Results	DWU Scenario		
	1 Bachman WTP	**2 Southeast WTP**	**3 WTP at Joe Pool**
Conveyance Capital Cost(1)	$171,132,000	n/a	n/a
Treatment Infrastructure Capital Cost	No Cost at Bachman WTP + Elm Fork Expansion (~$200,000,000)	$215,000,000	$204,000,000
Treatment Op. Cost (per MGal Treated)	$60	$66	$60
Present Value of 50-year Life-Cycle Cost	$782,604,000(2)	$572,321,000	$554,872,000
Notes	Costs for expanding DWU's overall treatment plant capacity by 102 mgd (by expanding the Elm Fork WTP if room for expansion is available) would be comparable to a new plant of the same size	Cost for conveyance is included in Project Conveyance Alternative costs	Cost for conveyance is included in Project Conveyance Alternative costs

Note (1): Distribution system costs (downstream of the WTP) are not included.
Note (2): The replacement of 102 mgd capacity at Elm Fork WTP is included in this figure. If this cost is excluded, the Present Value of the 50-year life-cycle cost is $335,572,000.

Modifications to Bachman WTP treatment process

- Biological filtration (currently being implemented);
- Additional ferric sulfate storage and feed facilities to meet desired TOC reduction (current enhanced coagulation improvements should meet these requirements); and
- Additional ozone generation capacity (approximately 200 lb/day) for manganese oxidation (existing plant ozonation facilities should be capable of providing this increased ozone requirement)

Proposed Southeast WTP

- Due to low alkalinity and elevated levels of TOC and manganese, the water would be more difficult to treat than the raw water from Scenario 1 (at Bachman WTP);
- Additional ferric sulfate addition would be required to meet desired TOC reduction; and

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Proposed Joe Pool Lake WTP: raw water quality would be the same as that for Scenario 1 (at Bachman WTP) and would require the same treatment process and treatment requirements.

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Based on the review of Joe Pool Lake, Lake Palestine, Cedar Creek Reservoir and Mountain Creek Lake water quality data, it is unlikely that routing water through Mountain Creek Lake to Bachman WTP will result in any significant drinking water quality concerns. These findings suggest that the option to route water through Mountain Creek Lake is a viable option with regards to drinking water quality.

9.2 Triple Bottom Line Business Case Evaluation

The project findings can be briefly summarized in terms of a comparison of positive or negative impacts of interconnection alternatives vs. baseline plans as shown in **Table 9-2** in a Triple Bottom Line Matrix.

Table 9-2
Triple Bottom Line Matrix
Comparison of Interconnection and Baseline Alternatives

Project Element	Economic	Environmental	Social
Capital Costs	+		
Life-cycle Cost	+		+
Water Treatment Implications	–		
Permitting/Constraints	+	–	
Environmental Water Quality		–	
Water Sharing and Timing, Redundancy, Flexibility	+	+	
Regional Cooperation and Future Water Supply	+	+	+
Ellis County Service			+

9.3 Recommendations

This initial feasibility study was tasked with assessing the "fatal flaws" and "business case" for a joint, integrated regional approach to water supply and raw water transmission. The findings of this study identify the economic, social and environmental potential of such a project, and clearly suggest that the prospect of interconnecting Lake Palestine through the TRWD system offers benefits that warrant further consideration.

Conceptual engineering and operational scenarios were analyzed in this effort; further analysis is needed to more fully develop how such a joint project would be planned, designed and operated to optimize economic and operational benefits to both systems. This subsequent effort must be initiated quickly due to impending supply constraints and is paramount to support development of institutional agreements and a financing strategy that will be required.

9.3.1 Conceptual Design Phase

It is recommended that TRWD and the City of Dallas proceed to a Conceptual Design Phase. The purpose of this second phase is to further develop:

- The conveyance alternatives (with more detailed hydraulic and operational analysis);
- The phasing potential of an integrated plan; and
- The cost analysis based on additional conceptual design details.

This will, in turn, support parallel organizational discussions regarding cost- and gain-sharing and the terms of a long-term institutional framework. At the conclusion of the conceptual design phase, both parties should have sufficient decision support to consider moving forward with detailed design and construction.

TRWD and the City of Dallas may, based upon the recommendations of this study, decide to further pursue joint interconnected raw water conveyance from Cedar Creek Reservoir, Richland–Chambers Reservoir and Lake Palestine. Despite a compressed timeframe for project development, careful additional study of the various issues mentioned above is recommended.

A conceptual design phase is recommended that would be jointly funded under an existing agreement between the City of Dallas and TRWD. Additional definition of infrastructure requirements at a conceptual level and further operational analysis will provide more detailed cost information. This report is a first step toward determining the viability of integrated water supply and transmission. The general OBJECTIVES of this planning and conceptual design process are:

1. Provide additional technical information to support the City of Dallas and TRWD and its primary wholesale customers with understanding project benefits and manage institutional and financial consequences;

2. Continue to advance project planning and development prior to detailed design to accommodate a 2015 delivery date;

3. Mitigate project cost and schedule variance; and

4. Ensure that the principles of the National Environmental Policy Act (NEPA) are considered early in the planning process to expedite all regulatory decisions, permitting and land acquisition.

Five **TASKS** have been identified to meet these objectives and will provide additional technical, operational, water quality, financial and contractual guidance to support decision making and project delivery. This information is needed so that that the City of Dallas, TRWD and its primary wholesale customers can make clear decisions regarding project costs, schedule, operations, and financing in support of a 2015 water delivery date:

1. Conceptual Design and Project Cost Analysis;

2. Environmental and Permitting Assessment (following NEPA principles);

3. Organizational and Financial Assessment;

4. Project Delivery, Schedule and Cost Management Plan; and

5. Delivery to DWU Water Treatment System.

Tarrant Regional Water District/ City of Dallas

SUMMARY REPORT
Amendment 2 of Phase 1 of the Raw Water Transmission System Integration Study

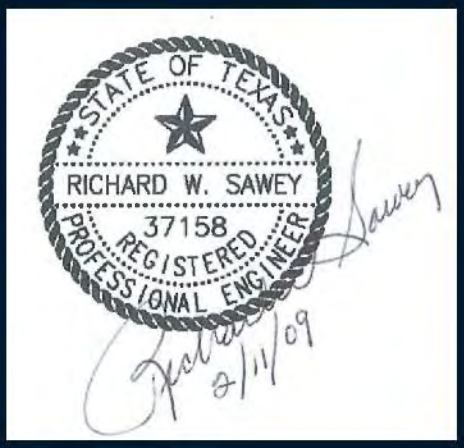
February, 2009

CDM

In Association with:
KBR and J. Stowe & Company

TARRANT REGIONAL WATER DISTRICT/ CITY OF DALLAS

SUMMARY REPORT
AMENDMENT 2 OF PHASE 1 OF THE RAW WATER TRANSMISSION SYSTEM INTEGRATION STUDY



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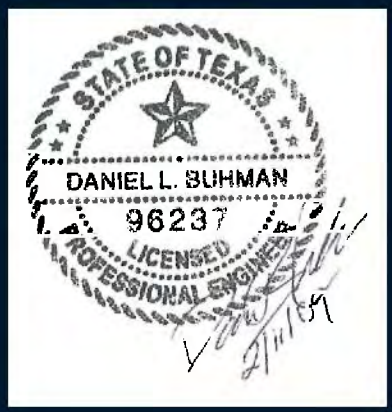

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Contents

Figures

Tables

Section 1
Introduction

1.1 Project Background

The Tarrant Regional Water District (TRWD) and the City of Dallas Water Utilities (DWU) have water rights or contracts involving 14 surface water reservoirs and operate raw water transmission facilities across North Central Texas. Dallas supplies treated and raw water to wholesale customers in Dallas, Collin, Denton, Ellis, and Kaufman Counties. TRWD supplies raw water and transmission services to Tarrant and 8 other counties in Region C and Johnson County in the Brazos G Region. TRWD and DWU provide drinking water to 4.4 million people, a population that is expected to double in the next 50 years.

Current population projections and water demand trends included in the 2006 Region C Regional Water Plan and the 2005 Update of the Dallas Long Range Water Supply Plan, as illustrated in **Figures 1-1a** and **1-1b**, will soon be updated with new water management strategy recommendations. These updates will include connecting Lake Palestine to the DWU water system, completion of the TRWD constructed wetlands, and construction of TRWD's Third East Texas Pipeline from Cedar Creek and Richland-Chambers Reservoirs.

The geographic proximity of Lake Palestine to the existing TRWD water supplies and raw water transmission facilities at Cedar Creek and Richland-Chambers Reservoirs (as shown in **Figure 1-2**) and the location, timing, and volumes of water demands prompted DWU and TRWD to discuss the opportunity to explore the feasibility of an integrated approach to bring additional water into the Dallas and Tarrant Regional Water District service areas.

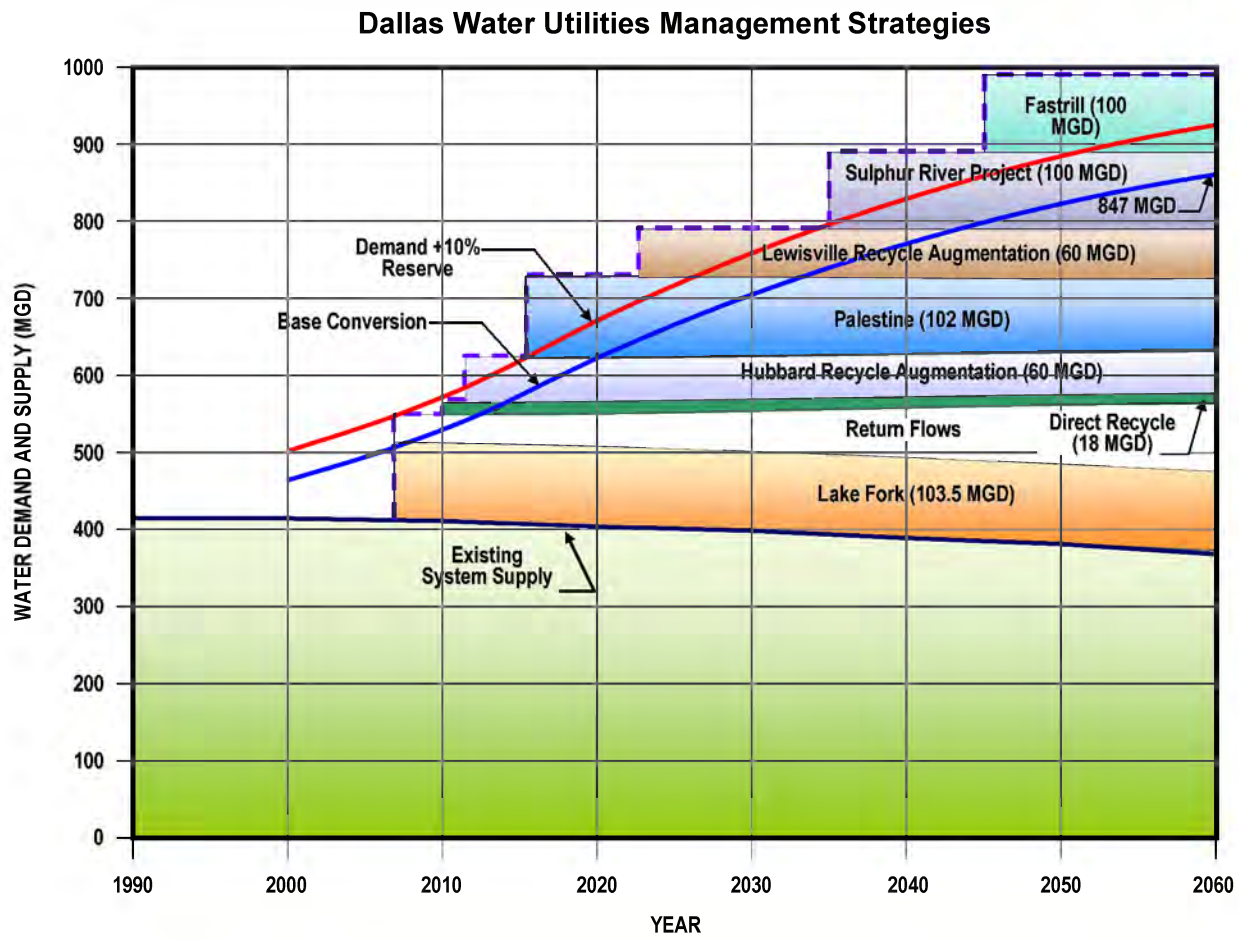

Figure 1-1a
DWU Water Management Strategies
(Figure from December 6, 2006 City Council Briefing)

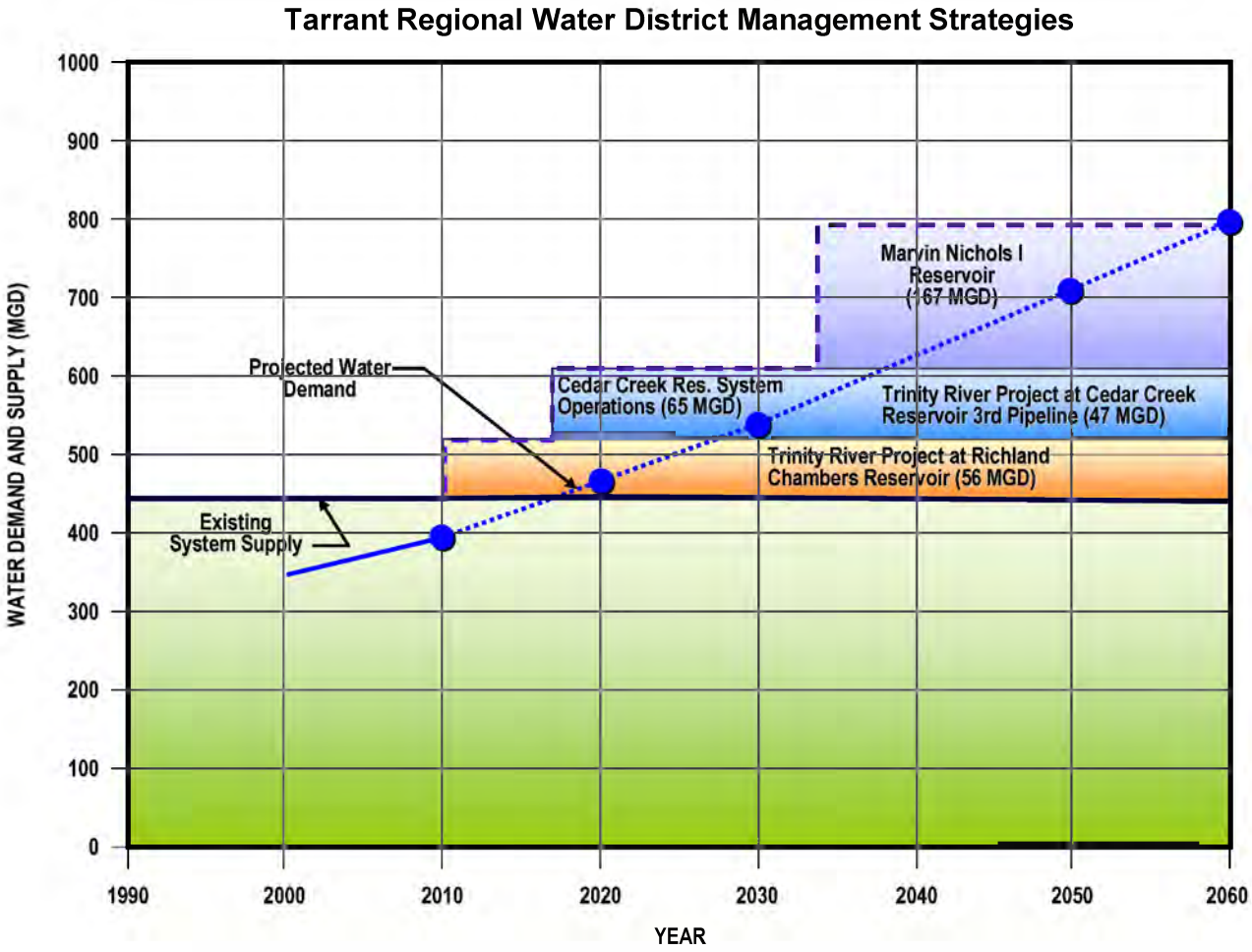

Figure 1-1b
TRWD Water Management Strategies
(based on 2006 Region C Water Plan numbers)

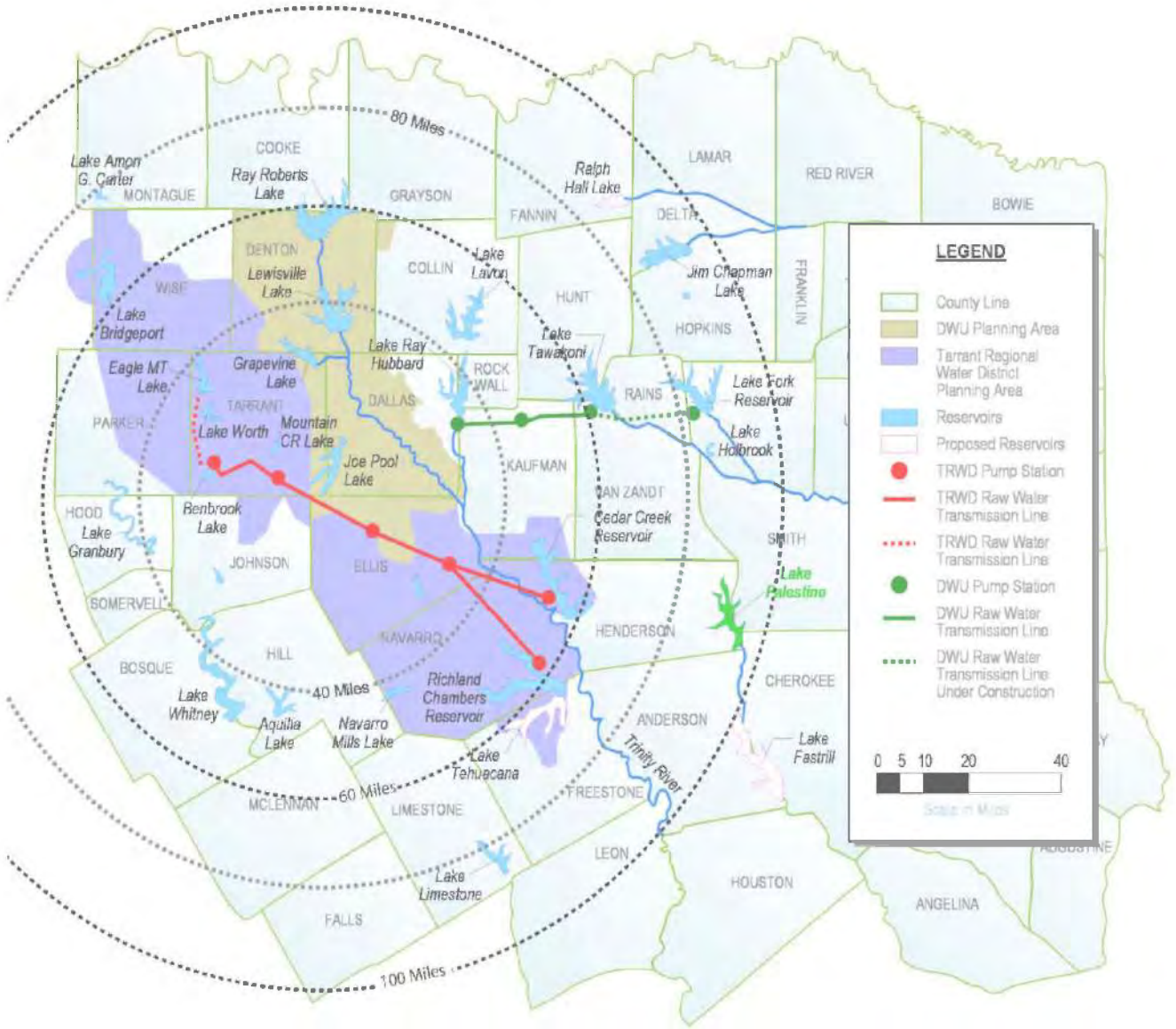

Figure 1-2
Vicinity Map

This report documents ongoing regional plan updates involving the initial project viability assessment and business case evaluation of integrating the TRWD and DWU raw water transmission systems, **Figure 1-2**.

1.2 Project Scope and Purpose

This report documents the results of Amendment 2 to the Phase 1 Project Viability Assessment and Business Case Evaluation. The purpose of the work authorized in Amendment 2 is to:

1. Provide additional analysis on, and refinement to, two interconnected conveyance alternatives (developed in Phase I: the Interconnected Third Pipeline and Interconnected Southern Pipeline) and recommend **a single alternative for continued evaluation**.

2. Prepare a **Project Development Plan** to identify the institutional, political, financial, and policy opportunities and barriers for a project of this magnitude and complexity. These project development issues include governance, contracting, project management, design, construction, operation, and financial issues such as cost- and gain-sharing, as well as water sharing, etc.; and

3. Developing a **Project Delivery Schedule** to guide the design and construction process.

In short, this planning and analysis will provide:

- **Decision-making support with regard to a potential contractual relationship between TRWD and the City of Dallas for joint raw water transmission;**

- **Information regarding a path forward for implementing a joint project (tasks and schedule); and**

- **A narrower range of options to be considered by recommending one interconnected conveyance alternative for further analysis and development.**

This information will lead to a decision between the two joint conveyance alternatives as shown in Table 1-1 and Figure 1-3.

Table 1-1
Project Conveyance Alternatives

Alternative	Description
1	**Interconnected Third Pipeline** (upsized as compared to the baseline condition) with connection of Lake Palestine to Cedar Creek Reservoir and delivery to DWU near Joe Pool Lake and TRWD's customers through the Third Pipeline
2	**Interconnected "Southern Pipeline"** - Lake Palestine delivered to the Lake Benbrook pipeline via a pipeline route to the south of the TRWD Third Pipeline route. Delivery to DWU near Joe Pool Lake and TRWD's customers through connections to the existing system and the Lake Benbrook pipeline.

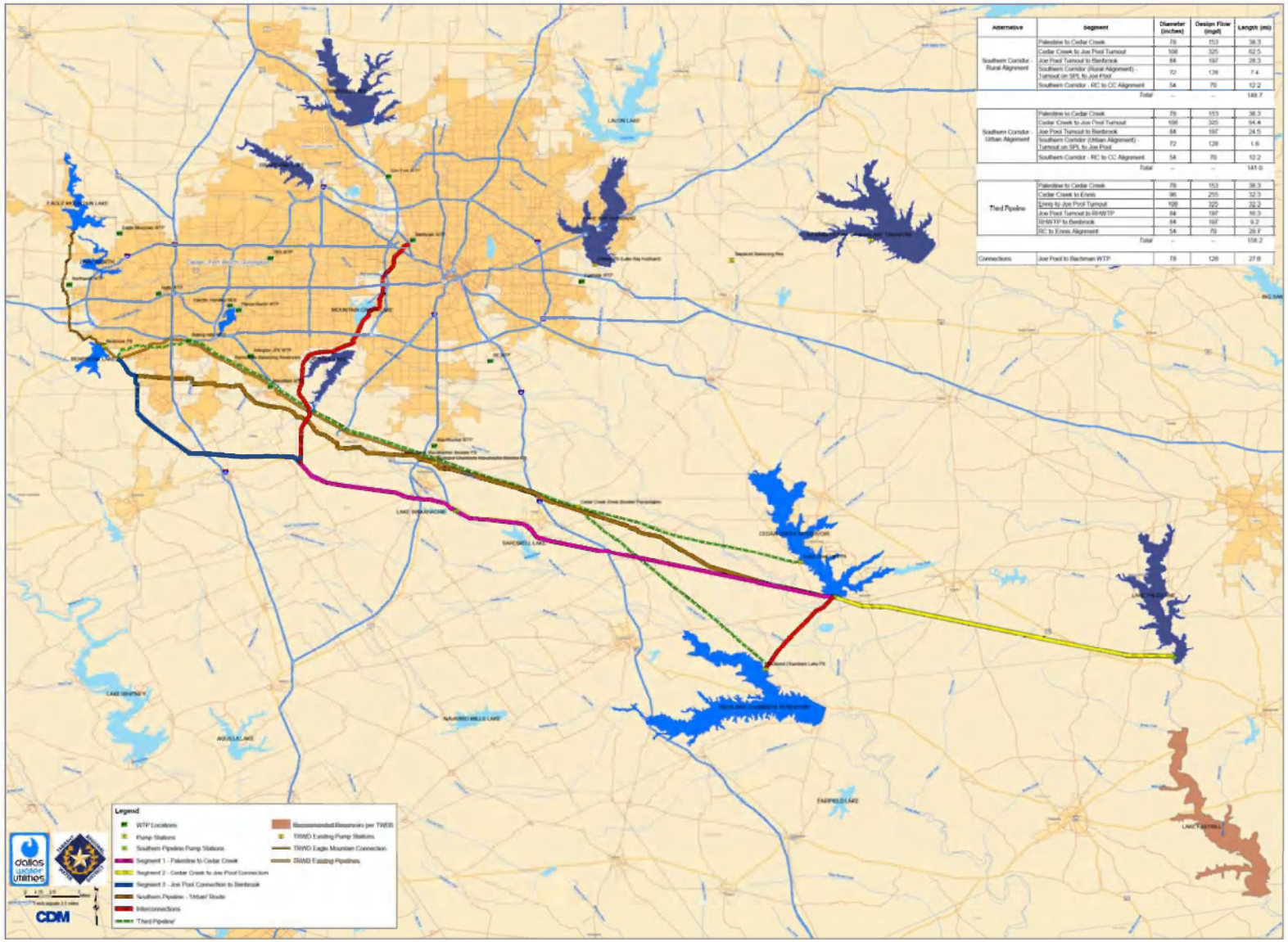

Figure 1-3
Study Area Limits

Section 2
Criteria and Standards

2.1 Purpose

The purpose of developing criteria and standards was to establish standard conditions for facilities, delivery operations, and cost analysis. Criteria and standards set modeling and cost variables at reasonable values adequate for this level of analysis. These standards are based on a technical workshop involving TRWD, the City of Dallas, and the consulting team and a technical memorandum reviewed by all participants. Standards were set based on owner and engineering judgment, previous analysis of this type, data from similar conveyance projects, and consensus among the project team.

2.2 Facilities and Delivery Operations

- Point of delivery:
  - **Third Pipeline –** need to add 150 mgd (plus 1.25 peak) from Rolling Hills WTP (RH WTP) to Lake Benbrook (BB) going west. Don't need to add any capacity from BB to RH WTP going east but could use that new pipeline to pump back for flexibility. So in this scenario, need new pipeline.
  - **Southern Pipeline (SPL) –** add zero going west and zero going east, so no new pipeline from RH WTP to BB. Connect the SPL at the end of the Benbrook pipeline tunnel, which is at the junction where the Benbrook connection splits to the Benbrook Outlet and the BB lake pump station (BB1). From this connection, the 150x1.25 needs to go west to BB2 and/or the Benbrook Outlet.
- Transmission system criteria.

Table 2-1
Transmission Criteria

Transmission Criteria	Integrated System
Maximum Working Pressure (psi)	200*
Peak Pipeline Velocity (ft/s)	8
Peaking Factor (Peak Q/Avg Q)	1.25 Exception: For Palestine to Cedar Creek, use a 1.5 peaking factor.
Booster Pump Station Ground Storage	2.5 hours at Peak Capacity
Balancing Storage at Pressure/Gravity Transition	5% of Rated Capacity

*Note: 200 psi is a reasonable limit for most plant's capabilities in spiral welded pipe of 120" diameter. The use of 50 ksi steel or rolled plate pipe (can pipe) would allow pressures of 260 to 375 psi or more.

- **Table 2-2** was supplied by TRWD to establish supply source and transmission system capacities:

Table 2-2
Permitted Reservoir Supplies and Related Transmission Pipeline Capacities

Reservoir System	Reservoir Supply Capacities				Transmission Pipeline Capacities									
	Storage Firm/Permit		Storage 2010 Safe		Existing Pipelines Maximum		Combined Pipelines Normal Day		Combined Pipelines Peak Day		New Joint Pipeline Normal Day		New Joint Pipeline Peak Day	
	Acre/Ft	MGD	Acre/Ft	MGD	Acre/Ft	MGD	Acre/Ft	MGD	Acre/Ft	MGD	Acre/Ft	MGD	Acre/Ft	MGD
CEDAR CREEK														
Reservoir	175,000	156	152,783	136	142,268	127	175,000	156	218,750	195	32,732	29	76,482	68
Wetlands	52,500	47	52,500	47	0	0	52,500	47	65,625	59	52,500	47	65,625	59
Sub-Total	**227,500**	**203**	**205,283**	**183**	**142,268**	**127**	**227,500**	**203**	**284,375**	**254**	**85,232**	**76**	**142,107**	**127**
RICHLAND-CHAMBERS														
Reservoir	210,000	187	188,444	168	275,574	246	210,000	187	275,574	246	-65,574	-59	0	0
Wetlands	63,000	56	63,000	56	0	0	63,000	56	78,750	70	63,000	56	78,750	70
Sub-Total	**273,000**	**244**	**251,444**	**224**	**275,574**	**246**	**273,000**	**244**	**354,324**	**316**	**-2,574**	-2	**78,750**	**70**
LAKE PALESTINE														
Reservoir	114,337	102	112,080	100	0	0	114,337	102	142,921	128	114,337	102	142,921	128
Wetlands	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sub-Total	**114,337**	**102**	**112,080**	**100**	**0**	**0**	**114,337**	**102**	**142,921**	**128**	**114,337**	**102**	**142,921**	**128**
GRAND TOTAL	**614,837**	**549**	**568,807**	**508**	**417,842**	**373**	**614,837**	**549**	**781,620**	**698**	**196,995**	**176**	**363,778**	**325**

Conditions and Limitations --

1. Existing Pipelines Capacities = Total CC and RC pipeline capacity (not cross-connected) from lake pump stations to RH-WTP.
2. Joint Pipelines Capacities = Total of Existing CC and RC pipeline capacities plus new joint pipeline capacity (not cross-connected).
3. New Joint Pipeline Capacities = Difference of existing and combined pipeline capacities.
4. The 1.25 peaking factor is applied to CC and RC wetlands.
5. The 1.25 peaking factor is applied for Palestine water from CC and RC reservoirs to the DWU delivery point (1.5 from Pal to CC/RC)
6. Capacities for existing TRWD and new joint pipelines apply only to pipelines originating from the CC and RC reservoirs.

Results --

1. New pipeline from CC and RC reservoirs to DWU delivery point = 325 MGD 363,778 Acre/Ft
2. New pipeline from DWU delivery point on to RH-WTP or Benbrook = 197 MGD 220,857 Acre/Ft

Table 2-3
Additional Pipeline Flow Capacities

	Existing System Peak Capacity @ 8fps (mgd)
Kennedale to RH WTP	127 + 228 = 355, 225 reverse flow
RH WTP to Benbrook	110 Gravity, 200 with RHBPS, 225 reverse flow

*Note: At 8 fps capacity is 146 mgd. Actual system constraints limit this value to 127 mgd.
**Note: Used 244 in Phase 1 Ops Model
†Note: 1.25 peaking factor

- Use Safe yield for planning, Firm yield for operations
  - Firm yield – maximum yield without a shortage of supply; reservoir would be empty at end of historical critical period.
  - Safe yield – maximum yield leaving a minimum storage equivalent to one year's supply in the reservoir at end of historical critical period.

Table 2-4
Permitted Yield

Storage Facility	Annual Permit/Contract Yield (ac-ft/yr)
Lake Palestine	114,337
Richland-Chambers Reservoir	210,000
Richland-Chambers Constructed Wetlands	63,000
Cedar Creek Reservoir	175,000
Cedar Creek Constructed Wetlands	52,500
Lake Benbrook	72,500
West Fork Trinity River (Eagle Mountain Lake, Lake Worth and Lake Bridgeport)	100,000 unless lakes are at <50% combined capacity, in which case 46,000

- Richland Chambers = 210,000 + 63,000 wetlands for a total of 273,000 ac-ft/yr. Wetlands are 100% operational in 2018. **Flow from Lake Palestine will be considered as additional available yield.**
- Cedar Creek = 175,000 + 52,500 wetlands for a total of 227,500 ac-ft/yr. Wetlands are 100% operational in 2018. **Flow from Lake Palestine will be considered as additional available yield.**

- Capacity of Kennedale Balancing Reservoir was 300 million gallons. They were recently relined and soil cement was added over 100% of area. Now 250 mg < capacity < 300 mg.

2.2.1 System Demands

- The TRWD supply from the combined system will be timed and quantified using the following guidelines:
  - **Table 2-5** (Data source: TRWD) specifies the timing and quantity of TRWD's customer demands.
  - It is assumed that the constructed wetlands (both Cedar Creek and Richland-Chambers) will be on-line before 2018
  - An appropriate factor of safety is applied by using safe yield for reservoir supply projections.

Table 2-5
Annual Average Demand by Decade and Withdrawal Location

	ANNUAL AVERAGE DEMAND (mgd)				
	2020	**2030**	**2040**	**2050**	**2060**
Mansfield WTP	13	17	21	25	29
Arlington JFK WTP	46	49	56	63	69
Arlington Pierce-Burch WTP	38	47	53	59	66
Rolling Hills WTP**	76	81	89	98	106
TRA Mosier Valley WTP	48	59	69	80	90
Eagle Mountain WTP*	65	80	95	110	127
Northwest WTP*	13	21	30	41	53
Holly WTP*	50	47	43	39	35
Fort Worth Southwest WTP**	10	13	15	18	20
Ellis County***	47	60	74	88	104
Cedar Creek Local W/D	4	5	6	7	8
Richland Chambers Local W/D	4	4	5	5	5
Lake Arlington Local WD	2	2	3	3	3
Benbrook Local W/D	4	6	7	8	9
Lake Worth Local W/D	4	4	4	4	4
Eagle Mountain Local W/D	2	3	3	4	4
Lake Bridgeport Local W/D	6	8	8	9	10
Full TRWD Demand	432	506	581	661	742
DWU Demand	0	55	102	102	102 ?

*Full demands for Holly WTP, Eagle Mountain WTP, and Northwest WTP are listed. West Fork will supply up to its permitted limit, and remainder of demand is on integrated system.
**Demand on Rolling Hills WTP reduced by estimated amount of Southwest WTP based on City of Fort Worth Water Master Plan, 2005
***Ellis County Gross Demand from the "Four County Study" currently underway.

- The Dallas supply from the integrated system will be timed and quantified using the following guidelines:
  - **Table 2-6** (Data source: City of Dallas Water Utilities 2005 Update - Long Range Water Supply Plan, December 2005 unless otherwise noted) specifies the timing and quantity of Dallas' need for additional supply.
  - **Table 2-6** does not show 2015 as the forecast date for a new supply source due to the pending increase in Lake Ray Hubbard permitted yield.
  - An appropriate factor of safety is applied when determining the date at which new water supply sources will be required.
  - This study assumes that Dallas does not intend to base load its system with the new supply from the integrated system. Therefore, demand on the integrated system will increase over time, resulting in potential phasing opportunities..

2.3 Cost Analysis

- Pipeline material assumed for the purposes of the cost analysis: Steel in urban settings, PCCP in rural
- Year for basis of cost: 3rd quarter 2008.
- Assumed transmission pipeline depth of cover is 4' in rural areas and 5' in urban areas
- Assume sufficient right-of-way purchase for two pipelines (one for a future line). Assume 140' permanent easement and 0' temporary easement.
- The cost estimate assumes an "Urban" classification for all pipelines within City limits. Urban areas were identified from areal maps and GIS. Urban areas were divided into "Low Urban", "Medium Urban", and "Heavy Urban", where varying production rates were assumed for each classification. In undeveloped urban areas or areas that are lightly populated (low density), a Low Urban rating was assigned. These areas have few visible surface constraints but may require relocation and/or protection of existing underground utilities since the work is within populated areas. A Medium Urban rating was assigned to portions of the alignment in areas having a moderate level of residential, commercial and industrial development. A Heavy Urban rating was assigned to densely developed areas that will require a large amount of surface restoration and likely involve a high degree of utility relocations
- To make an "apples to apples" comparison with the Integrated Southern Pipeline (which includes ROW for two pipelines), assume in the Integrated Third Pipeline alternative the purchase of additional permanent ROW for one future pipeline.

Because there is no room adjacent to the existing ROW, this new permanent easement will be in a southern route. Therefore, this analysis will calculate cost for purchase of ROW sufficient for 2 additional pipelines (140') regardless of project alternative (Southern or Third Pipeline).

- Per Region C 2006 Water Plan, price per acre of rural right-of-way was $3,000/acre for permanent and $1,500 for temporary; and the price per acre of urban right-of-way was $30,000/acre. Based on recent costs incurred by TRWD and Dallas, these will be modified to $15,000/acre rural and $70,000/acre urban.

- Engineering, legal services, environmental-archeological studies, mitigation, permitting, and contingencies are accounted for as specified in Appendix U of the Region C 2006 Water Plan:

    - Environmental-archeological studies, mitigation, permitting, and contingencies are 1% of the capital construction cost.

    - 30% is added to pipeline elements and 35% to other components to cover engineering, legal, and contingency

Table 2-6
Supply-Demand Table: City of Dallas Water Utilities 2005 Update - Long Range Water Supply Plan, December 2005

				Demand (MGD) Met by:															
Year	Population	Demand MGD[1,2]	Conser-vation	Direct Reuse	Lake Ray Hubbard	Lake Ray Hubbard Additional Yield	Reuse in Hubbard[5]	Elm Fork ROR (CF75)	Elm Fork OverDraft 5414	Elm Fork Reuse[6]	Grape-vine[7]	Lew-isville	Lew-isville Reuse[8]	Lake Tawakoni	Ray Roberts	Lake Fork[9]	Lake Palestine	Total	Balance
2010	2,770,001	529.36	15.7	18.3	80.1	--	28.1	10.0	9.0	15.3	10.0	85.9	8.9	163.9	56.2	102.5	–	**603.9**	74.5
2011	2,817,581	537.04	16.2	18.3	80.1	--	28.5	10.0	9.0	15.7	10.0	85.9	9.6	163.8	56.2	102.5	–	**605.8**	68.7
2012	2,865,161	544.73	16.7	18.3	80.1	--	28.8	10.0	9.0	16.1	10.0	85.9	10.4	163.7	56.2	102.5	–	**607.6**	62.9
2013	2,912,741	552.41	17.2	18.3	80.1	--	29.2	10.0	9.0	16.5	10.0	85.9	11.1	163.5	56.2	102.5	–	**609.5**	57.1
2014	2,960,321	560.10	17.7	18.3	80.1	--	29.5	10.0	9.0	16.8	10.0	85.9	11.9	163.4	56.2	102.5	–	**611.4**	51.3
2015	3,007,902	567.78	18.2	18.3	80.1	--	29.9	10.0	9.0	17.2	10.0	85.9	12.7	163.3	56.2	102.5	–	**613.3**	45.5
2016	3,055,482	575.46	18.7	18.3	80.1	--	30.3	10.0	9.0	17.6	10.0	85.9	13.4	163.2	56.2	102.5	–	**615.2**	39.7
2017	3,103,062	583.15	19.2	18.3	80.1	--	30.6	10.0	9.0	18.0	10.0	85.9	14.2	163.1	56.2	102.5	–	**617.1**	33.9
2018	3,150,642	590.83	19.7	18.3	80.1	--	31.0	10.0	9.0	18.4	10.0	85.9	14.9	162.9	56.2	102.5	–	**618.9**	28.1
2019	3,198,222	598.52	20.2	18.3	80.1	--	31.3	10.0	9.0	18.8	10.0	85.9	15.7	162.8	56.2	102.5	–	**620.8**	22.3
2020	3,245,802	606.20	20.7	18.3	80.1	--	31.7	10.0	9.0	19.2	10.0	85.9	16.4	162.7	56.2	102.5	–	**622.7**	16.5
2021	3,284,012	614.38	21.1	18.3	80.1	--	32.1	10.0	9.0	19.5	10.0	85.9	17.0	162.6	56.2	102.5	–	**624.3**	9.9
2022	3,322,222	622.57	21.6	18.3	80.1	--	32.5	10.0	9.0	19.7	10.0	85.9	17.6	162.5	56.2	102.5	–	**625.9**	3.3
2023	3,360,432	630.75	22.0	18.3	80.1	--	32.8	10.0	9.0	20.0	10.0	85.9	18.2	162.3	56.2	102.5	102.0	**729.4**	98.7
2024	3,398,642	638.94	22.5	18.3	80.1	--	33.2	10.0	9.0	20.3	10.0	85.9	18.8	162.2	56.2	102.5	102.0	**731.0**	92.1
2025	3,436,852	647.12	22.9	18.3	80.1	--	33.6	10.0	9.0	20.6	10.0	85.9	19.4	162.1	56.2	102.5	102.0	**732.6**	85.5
2026	3,475,061	655.30	23.3	18.3	80.1	--	34.0	10.0	9.0	20.9	10.0	85.9	20.0	162.0	56.2	102.5	102.0	**734.2**	78.8
2027	3,513,271	663.49	23.8	18.3	80.1	--	34.4	10.0	9.0	21.2	10.0	85.9	20.6	161.9	56.2	102.5	102.0	**735.7**	72.2
2028	3,551,481	671.67	24.2	18.3	80.1	--	34.7	10.0	9.0	21.4	10.0	85.9	21.2	161.7	56.2	102.5	102.0	**737.3**	65.6
2029	3,589,691	679.86	24.7	18.3	80.1	--	35.1	10.0	9.0	21.7	10.0	85.9	21.8	161.6	56.2	102.5	102.0	**738.9**	59.0
2030	3627901	688.04	25.1	18.3	80.1	--	35.5	10.0	9.0	22.0	10.0	85.9	22.3	161.5	56.2	102.5	102.0	**740.4**	52.4
2031	3,661,218	694.06	25.6	18.3	80.1	--	35.8	10.0	9.0	22.0	10.0	85.9	22.9	161.4	56.2	102.5	102.0	**741.7**	47.6
2032	3,694,534	700.07	26.0	18.3	80.1	--	36.1	10.0	9.0	22.0	10.0	85.9	23.5	161.3	56.2	102.5	102.0	**742.9**	42.9
2033	3,727,851	706.09	26.5	18.3	80.1	--	36.5	10.0	9.0	22.0	10.0	85.9	24.1	161.1	56.2	102.5	102.0	**744.2**	38.1
2034	3,761,168	712.10	26.9	18.3	80.1	--	36.8	10.0	9.0	22.0	10.0	85.9	24.7	161.0	56.2	102.5	102.0	**745.5**	33.4
2035	3,794,485	718.12	27.4	18.3	80.1	--	37.1	10.0	9.0	22.0	10.0	85.9	25.3	160.9	56.2	102.5	102.0	**746.7**	28.6
2036	3,827,801	724.13	27.9	18.3	80.1	--	37.4	10.0	9.0	22.0	10.0	85.9	25.9	160.8	56.2	102.5	102.0	**748.0**	23.8

Table 2-6 (cont.)
Supply-Demand Table: City of Dallas Water Utilities 2005 Update - Long Range Water Supply Plan, December 2005

				Demand (MGD) Met by:														
Year	Population	Demand MGD[1 2]	Conser-vation	Direct Reuse	Lake Ray Hubbard	Lake Ray Hubbard Additional Yield	Reuse in Hubbard[5]	Elm Fork ROR (CF75)	Elm Fork OverDraft 5414	Elm Fork Reuse[6]	Grape-vine[7]	Lew-isville	Lew-isville Reuse[8]	Lake Tawakoni	Ray Roberts	Lake Fork[9]	Lake Palestine	Total	Balance
2037	3,861,118	730.15	28.3	18.3	80.1	–	37.7	10.0	9.0	22.0	10.0	85.9	26.5	160.7	56.2	102.5	102.0	**749.2**	19.1
2038	3,894,435	736.16	28.8	18.3	80.1	–	38.1	10.0	9.0	22.0	10.0	85.9	27.1	160.5	56.2	102.5	102.0	**750.5**	14.3
2039	3,927,751	742.18	29.2	18.3	80.1	–	38.4	10.0	9.0	22.0	10.0	85.9	27.7	160.4	56.2	102.5	102.0	**751.7**	9.5
2040	3961068	748.19	29.7	18.3	80.1	–	38.7	10.0	9.0	22.0	10.0	85.9	28.3	160.3	56.2	102.5	102.0	**753.0**	4.8
2041	3,990,335	753.43	30.2	18.3	80.1	–	38.8	10.0	9.0	22.0	10.0	85.9	28.9	160.2	56.2	102.5	102.0	**754.0**	0.5
2042	4,019,601	758.66	30.6	18.3	80.1	–	38.8	10.0	9.0	22.0	10.0	85.9	29.5	160.0	56.2	102.5	102.0	**755.0**	(3.7)
2043	4,048,868	763.90	31.1	18.3	80.1	–	38.9	10.0	9.0	22.0	10.0	85.9	30.1	159.9	56.2	102.5	102.0	**756.0**	(7.9)
2044	4,078,134	769.14	31.6	18.3	80.1	–	39.0	10.0	9.0	22.0	10.0	85.9	30.6	159.8	56.2	102.5	102.0	**757.0**	(12.2)
2045	4,107,401	774.38	32.1	18.3	80.1	–	39.1	10.0	9.0	22.0	10.0	85.9	31.2	159.7	56.2	102.5	102.0	**758.0**	(16.4)
2046	4,136,668	779.61	32.5	18.3	80.1	--	39.1	10.0	9.0	22.0	10.0	85.9	31.8	159.5	56.2	102.5	102.0	**759.0**	(20.6)
2047	4,165,934	784.85	33.0	18.3	80.1	--	39.2	10.0	9.0	22.0	10.0	85.9	32.4	159.4	56.2	102.5	102.0	**760.0**	(24.9)
2048	4,195,201	790.09	33.5	18.3	80.1	--	39.3	10.0	9.0	22.0	10.0	85.9	33.0	159.3	56.2	102.5	102.0	**761.0**	(29.1)
2049	4,224,467	795.32	33.9	18.3	80.1	--	39.3	10.0	9.0	22.0	10.0	85.9	33.6	159.1	56.2	102.5	102.0	**762.0**	(33.3)
2050	4253734	800.56	34.4	18.3	80.1	--	39.4	10.0	9.0	22.0	10.0	85.9	34.2	159.0	56.2	102.5	102.0	**763.0**	(37.6)
2051	4,278,959	805.25	34.9	18.3	80.1	--	39.4	10.0	9.0	22.0	10.0	85.9	34.2	158.9	56.2	102.5	102.0	**763.4**	(41.9)
2052	4,304,184	809.94	35.4	18.3	80.1	--	39.4	10.0	9.0	22.0	10.0	85.9	34.2	158.8	56.2	102.5	102.0	**763.8**	(46.2)
2053	4,329,408	814.63	35.9	18.3	80.1	--	39.4	10.0	9.0	22.0	10.0	85.9	34.2	158.6	56.2	102.5	102.0	**764.1**	(50.5)
2054	4,354,633	819.32	36.4	18.3	80.1	--	39.4	10.0	9.0	22.0	10.0	85.9	34.2	158.5	56.2	102.5	102.0	**764.5**	(54.8)
2055	4,379,858	824.02	36.9	18.3	80.1	--	39.4	10.0	9.0	22.0	10.0	85.9	34.2	158.4	56.2	102.5	102.0	**764.9**	(59.1)
2056	4,405,083	828.71	37.4	18.3	80.1	--	39.4	10.0	9.0	22.0	10.0	85.9	34.2	158.3	56.2	102.5	102.0	**765.3**	(63.4)
2057	4,430,308	833.40	37.9	18.3	80.1	--	39.4	10.0	9.0	22.0	10.0	85.9	34.2	158.2	56.2	102.5	102.0	**765.7**	(67.7)
2058	4,455,532	838.09	38.4	18.3	80.1	--	39.4	10.0	9.0	22.0	10.0	85.9	34.2	158.0	56.2	102.5	102.0	**766.0**	(72.0)
2059	4,480,757	842.78	38.9	18.3	80.1	--	39.4	10.0	9.0	22.0	10.0	85.9	34.2	157.9	56.2	102.5	102.0	**766.4**	(76.4)
2060	4505982	847.47	39.4	18.3	80.1	--	39.4	10.0	9.0	22.0	10.0	85.9	34.2	157.8	56.2	102.5	102.0	**766.8**	(80.7)

Data source: City of Dallas Water Utilities 2005 Update - Long Range Water Supply Plan, December 2005 unless otherwise noted.

[1]Irving's demand is reduced by Irving's Supply form Lake Chapman (39 MGD)

[2]Upper Trinity Regional Water District' demands are reduced by UTRWD's Lake Chapman and Reuse Supplies (up to 42 MGD)

[3]Assumes permitted use for Lake Ray Hubbard (CA-08-2462).

[4]Note not used

[5]Wastewater discharge projections provided by NTMWD

[6]Return flows from City of Lewisville WWTP and City of Flower Mound WWTP

[7]Yield developed by staff

[8]Wastewater discharge projections provided by NTMWD reduced 5% to account for Denton's water right.

[9]Lake Fork supply reduced to account for TXU exercising its option.

Section 3
Integrated Conveyance Alternatives

3.1 Purpose

The purpose of on-going analysis on integrated conveyance alternative corridors is to compare the Southern Pipeline and Third Pipeline corridor options and recommend a preferred option for connecting Lake Palestine and additional Cedar Creek and Richland-Chambers Reservoir water to the Dallas-Fort Worth Metroplex.

To make this comparison, the Southern Pipeline corridor was first refined to minimize overall capital cost by shortening its length while retaining other desirable characteristics. This refinement was necessary because the initial corridor selected at the beginning of Phase 1 was a "bounding" option, meant to bracket cost implications with both a maximum and minimum cost option. Therefore, the original corridor was the longest (farthest south of the existing TRWD right-of-way) making this an expensive alternative. While this provided information needed only to decide if system integration was feasible under a "worst-case" cost scenario, clearly further refinement would lower the estimated cost. The result of the initial analysis was that "yes", system integration is feasible and beneficial; therefore, this analysis refines the Southern Pipeline corridor to make a more direct cost comparison to the Third Pipeline corridor to support selection of a single conveyance alternative for further analysis.

Second, both corridors were further refined by more accurately categorizing the density of urbanization along the pipeline and in terms of cost. Cost analyses are documented in Section 7.

Third, the implications of power supply redundancy were considered. The existing TRWD transmission system utilizes booster pump stations at Ennis and Waxahachie. If the Third Pipeline corridor alternative is selected, existing pump stations would be expanded and power supply delivery would not diversify. However, if the Southern Pipeline alternative is selected, new booster pump stations would be required. This analysis considered the power supply to these pump stations (as compared to the existing stations) and what power supply redundancy could exist due to new booster station locations on the electrical grid

Athough the original intent of on-going analysis was to refine the Southern Pipeline to one conveyance alternative, two options for this corridor emerged – a southern pipeline alternative through mostly rural areas and an alternative through more urbanized areas. Therefore, two Southern Pipeline corridor alternatives and one Third Pipeline alternative are described below. This section provides a narrative description of the corridor selection, tables documenting pipeline length and size (as determined by hydraulic analysis and criteria described in other sections), and a description of the power supply redundancy research; Appendix A contains more detailed mapping of the pipeline corridor alternatives.

3.2 Southern "Urban" Pipeline Corridor

The following list provides a narrative description of the Southern "Urban" Pipeline Corridor.

- From Palestine to Cedar Creek Reservoir is almost a straight line. Deviations were made to avoid one high spot at the beginning and an urban area, but otherwise it is the shortest route to the Cedar Creek dam, where TRWD has discussed siting its next lake pump station.

- From Cedar Creek, the line swings a bit farther west to avoid multiple crossings of the Trinity River and forested wetland areas. An added benefit is picking up some existing utility ROW's for potential simplification of easement acquisition.

- This existing utility ROW is departed from at FM 85. The line skirts west to avoid what appear to be some ponds and then follows FM 85 until the road is flanked on both sides by homes. These are avoided by heading to the north side of the homes and the route then continues NW through rural areas.

- At Ennis PS, the new line is only about 2,000 feet south of the existing PS.

- This path continues until the north end of Ennis, where the corridor splits into two possibilities – an **'Urban'** Corridor and a **'Rural'** Corridor. The 'urban' corridor attempts to stay as far north as possible and pick its way through urban areas by following existing utilities (like power lines) and roads. The 'rural' corridor tries to stay south of urbanization, though this is not completely possible, and pass through less dense urban areas.

- The north end of Ennis is planned in the Ennis future land use plan for Low Density Residential.

- At I-45, the new line is only about 1,000' south of the existing pipelines because the north end of Ennis is much less densely urbanized.

- The line continues to parallel the existing lines, though a bit farther south (~2,000') until it reaches the NE end of Waxahachie. At this point, the corridor cuts due west in between some urban development, then NW through some open fields and then more due west to the crossing at I-35E. These turns are only made to avoid existing urbanization. However, future land use along the I-35, Highway 77, 287 triangle is commercial, industrial, and retail. Depending on the time of development, this may be a difficult area to cross.

- After I-35E there is a turn to the NW to get to the north side of some development, then the line cuts almost due west and runs in Marshall road and then continues to run past the south end of Midway airport.

- This continues past 287 until the line cuts NW parallel to a natural gas gathering line that runs past Watson Lake. It turns west at Mount Zion road and follows this to stay south of 287.

- The area south of 287 is urbanizing into three zones per the Midlothian future land use plan (NCTCOG source). The area this line would pass through is planned for Country Module and Suburban Module development, both heavily residential and only really differing in lot size and multi-family housing.

- At the west end of some existing development, the line turns due north until it meets an Atmos pipeline, then it turns NW and runs somewhat parallel to 287. This area of Midlothian is also planned for development – industrial to the area just west of where the line turns due north, and 'regional' land use then more suburban and then 'village' module land use types. This area may be very difficult to cross depending on when it is developed. If it needs to be avoided, the line should not turn due north but should continue west through the 'industrial' area until it gets west of 67 some distance. When the line runs somewhat parallel to 287, it is running in the Old Fort Worth road, which has structures (not dense) on the south side but not the north (as of early 2007).

- The line continues parallel to 287, at one point within 1,000', cuts due west to follow St. Paul Rd for a short distance, then continues jogging NW and west to avoid existing urban developments.

- Now at the south end of Midlothian, the line continues west until it reaches a Southwestern Gas Pipeline ROW and then turns more north and follows this ROW until reaching FM 1187 (Rendon Bloodworth Road). This is where the line snakes its way west, along the road.

- 8,700' east of Spinks airport, there are two choices. One is to continue along FM 1187, which in truth is not large enough for a 140' ROW. The other is to follow a Barnett Gathering, LP line to the north until reaching a dual power line ROW, which could be followed west. At the I-35W crossing, the power line easement is 4,200' north of the FM 1187 crossing.

- If FM 1187 is used past I-35W (as we head west), it continues to be followed as it turns a bit south and then continues west until just east of FM 1902 (Old Granbury Road). If the power line ROW is used, it stays farther north and then turns north at the same location east of FM 1902, but 9,900' to the north of the point where the FM 1187 following run turns north.

- The line runs due north until terminating at the end of the Benbrook connection tunnel.

Table 3-1
Southern "Urban" Corridor Sizing, Flow, Length

Segment	Diameter (inches)	Design Flow (mgd)	Length (mi)
Palestine to Cedar Creek	78	153	38.3
Cedar Creek to Joe Pool Turnout	108	325	64.4
Joe Pool Turnout to Benbrook	84	197	24.5
Interconnection to Joe Pool Vicinity	72	128	1.6
Richland-Chambers to Cedar Creek Interconnection	54	70	12.2
Total	--	--	141.0

3.3 Southern "Rural" Pipeline Corridor

- From Palestine to Cedar Creek Reservoir is almost a straight line. Deviations were made to avoid one high spot at the beginning and an urban area, but otherwise it is the shortest route to the Cedar Creek dam, where TRWD has discussed siting its next lake pump station.

- From Cedar Creek, the line runs in nearly a direct path to the south side of Ennis and then runs on the south side of Ennis, very close to the eastern edge of Bardwell Lake.

- At Ennis PS, the southern 'rural' pipeline corridor is roughly 5 miles south of the existing PS.

- This route could accommodate deliveries to Lake Bardwell for local use in Ellis County. The southern end of Ennis is land used for future low density residential, while the north end where the corridor could also run through is commercial/industrial. It would essentially parallel 287's run along south Ennis.

- The corridor could also split directly north of Ennis at I-45. From there it would bare west (and just slightly south) to get to the south end of Waxahachie, running across open areas.

- It appears more favorable to run south of Ennis to diversify pump station power supply, proximity to Lake Bardwell and corridor compatibility with current and future land use. It does add some length to the pipe, but that length might be worth the proximity to Bardwell.

- At the south end of Waxahachie (though north of Lake Waxahachie), the line runs west through an area deemed 'mixed use non-residential' and retail in the future land use plan. It actually runs through the border of this land use and the 'highway commercial' land use (same as in the 'urban' corridor). The rest of the area is low density residential/estate.

- The line continues west, essentially avoiding urbanization by staying south of that zone.

- The line runs far south of Midlothian. Though it could be cut closer in to Midlothian, it is likely that it would result in a longer line because of some turns that would be needed to avoid urbanization, or it would result in more urban conflicts.

- Just past the future SH 360 corridor, just east of Venus, the line turns due west and runs north of Venus, snaking through what appears to be very light residential on the west side of FM 2738. The line continues running NW, past the north side of Alvarado and then runs through the north end of Egan. There it meets up with the future Regional Outer Loop - Loop 9 corridor that NCTCOG has in their plans. It is part of the Trans-Texas corridor. It does not have a pending EA/EIS or is not yet under study, but it is a conceptual idea that may get some traction by the time this line is built.

- At FM 1902 (Old Granbury Road), the line turns north and follows this road to the Tarrant/Johnson county border. FM 1902 turns a bit west at that point and our line leaves the road and continues due north to Lake Benbrook.

Table 3-2
Southern "Rural" Corridor Sizing, Flow, Length

Segment	Diameter (inches)	Design Flow (mgd)	Length (mi)
Palestine to Cedar Creek	78	153	38.3
Cedar Creek to Joe Pool Turnout	108	325	62.5
Joe Pool Turnout to Benbrook	84	197	28.3
Interconnection to Joe Pool Vicinity	72	128	7.4
Richland-Chambers to Cedar Creek Interconnection	54	70	12.2
Total	--	--	148.7

3.4 Third Pipeline Corridor

- The Third Pipeline follows the existing ROW from Cedar Creek to Rolling Hills WTP. Between Lake Palestine and Cedar Creek Reservoir, the corridor is the same as the Southern Pipeline. However, this corridor runs into Cedar Creek at the dam; to pump this water through the existing ROW, a new line is required from this location up north to the existing pump station location, or start of the existing ROW. Therefore, a line was built following FM 274. It is possible that the intake at CC would be used only for a southern route, but this alternative assumes the Third Pipeline is being built in the existing ROW and therefore a line is needed from this new intake to the existing ROW per the shortest route (to the existing ROW).

- The Third Pipeline consists of a line from Cedar Creek to the existing Ennis PS, and a line from Richland-Chambers to Ennis PS (a line from Richland-Chambers is needed and is comparable to the Richland-Chamber to Cedar Creek connection in the Southern Pipeline option), then a joint line to Rolling Hills WTP.

- From Rolling Hills WTP, a new line is needed to Lake Benbrook. This line is sized for 150 mgd.

- The line from Rolling Hills WTP to Lake Benbrook is difficult to build because of the heavy urbanization in this area. A tunnel is assumed at this time for the entire length.

Table 3-3
Third Pipeline Corridor Sizing, Flow, Length

Segment	Diameter (inches)	Design Flow (mgd)	Length (mi)
Palestine to Cedar Creek	78	153	38.3
Cedar Creek to Ennis	96	255	32.3
Ennis to Joe Pool Turnout	108	325	32.3
Joe Pool Turnout to RHWTP	84	197	16.3
RHWTP to Benbrook	84	197	9.2
RC to Ennis Alignment	54	70	29.7
Total	--	--	158.2

Table 3-4
Approximate Lengths of Urban and Rural Reaches

Pipe Segment	Rural (mi)	Low Urban (mi)	Medium Urban (mi)	Heavy Urban (mi)	Special Crossings / Tunnel	Total
3PL	75.1	30.7	10.7	1.7	10.5	128.7
SPL (Urban)	94.0	27.4	4.9	--	1.2	127.4
SPL (Rural)	118.7	7.6	1.9	--	1.1	129.3

Note: Lengths represent main transmission line, not interconnections (Richland-Chambers to Cedar Creek, Southern Pipeline to Joe Pool Lake vicinity, Joe Pool Lake vicinity to Bachman WTP)

3.5 Interconnection to Joe Pool Lake Vicinity

- The connection to the Joe Pool Lake vicinity follows the SH 360 corridor, as currently conceptualized by NCTCOG. It ties into the existing transmission lines at the existing blind flange on the TRWD pipeline.

3.6 Connection to Cedar Creek from Richland Chambers

- This line does not follow the existing ROW from Richland Chambers to Ennis PS, even at the beginning, so that the existing ROW remains available for a future pipeline.

- The line does not follow an exact straight line to Cedar Creek Reservoir so that some deciduous forest land near Rush Creek and the Trinity River can be avoided and to accomodate a more direct crossing of the Trinity River.

- This corridor assumes that the delivery point is at the new Cedar Creek intake PS location. This delivery location may move to the west along the Southern Pipeline to avoid a Trinity River crossing, shorten the connection, or perhaps for operational reasons.

3.7 Connection to Dallas Bachman WTP from Joe Pool Lake Vicinity

The preliminary corridor selection between the existing blind flange on the TRWD Richland-Chambers pipeline near Joe Pool Lake and the Dallas Bachman WTP is described in Section 8 of the initial report for this project. The preliminary Bachman corridor selection was not modified in this analysis.

Table 3-5
Interconnection to Bachman WTP: Sizing, Flow, Length

Segment	Diameter (inches)	Design Flow (mgd)	Length (mi)
Joe Pool to Bachman WTP	78	128	27.8

3.8 Energy Delivery Redundancy / Diversification

Reliable electrical power is essential to the operation of the pump stations. There are several methods available to increase reliability of service, including redundant feeders, taking service from a more stable system, and alternative water transmission facilities.

3.8.1 Electrical Distribution Facilities

The electrical distribution system is defined as voltages below 69,000 V. The electric feeders on this system generally originate in a substation and continue one way (radial) to the end. Customers are served from locations all along the line. If there is a failure anywhere along the line, then the entire line is out of service. The pump stations would require a more dependable level of service, which could be accomplished by a second feeder to each station, originating in a different substation and travelling along a completely separate route without sharing any common structures.

3.8.2 Electrical Transmission Facilities

For loads as large as the pump stations on this project, a more stable electrical source is available from the transmission system. The transmission system is a grid, or network configuration. Most lines have a substation or switching equipment at each end, and can therefore be fed from either end. This inherently provides the redundancy of a second feeder from a separate source, as described for distribution lines. If transmission service is taken, then a substation will be needed to convert the transmission level voltage (usually 138,000 V for transmission lines in this area) to the voltage to be used by the pump stations. The substations may be owned and operated by the electric utilities, or by the customer. A utility owned substation might reduce the initial cost and maintenance costs, but the construction schedule would probably be increased, and operational costs (electric bills) would be higher. The ownership of the substations would be negotiated with each electric utility separately, as would the potential for distribution level service with the appropriate redundancy and diversification for reliable service.

3.8.3 Electrical Service Costs

In any electrical service configuration, the electric utility will calculate costs for what is termed "standard facilities." This is the minimum construction required to serve the load. It might include a single distribution line, or several miles of transmission lines. The anticipated billing for the load is used to partially offset the cost of standard facilities. Any additional construction costs incurred by the electric utility would be paid by the customer as a "Contribution In Aid Of Construction" (CIAC) which is a one time, nonrefundable payment to the utility before they begin design or construction of the facilities. Any and all facilities requested by the customer in excess of the standard facilities would also require a CIAC to be paid.

Electric transmission line construction by the electric utility would also require that a "Certificate of Convenience and Necessity" (CCN) be undertaken. This process is very lengthy (up to two years, just to obtain approval to build the line) and as it includes public hearings, the outcome is not guaranteed. Private entities (customers) may construct transmission lines for their own use without going through the CCN process.

3.8.4 Alternative Water Transmission Facilities

The proposed pump stations on the Southern 'Rural' Corridor are located such that electrical transmission service can be obtained from a different portion of the transmission grid than that used by the existing pump stations on the Cedar Creek and Richland-Chambers pipelines at Ennis and Waxahachie. In the unlikely event of a transmission system outage, both pipeline systems (Existing and Southern) would probably not be affected at the same time.

The electric transmission lines in this area of Texas are mostly owned by Oncor Electric Delivery. However, because some of the existing and new Southern Pipeline pump stations are located in areas in which a different company owns exclusive franchise, the final line connections may be by a different utility. This does not create a better or worse situation, but this configuration requires coordination with both Oncor and the alternate utility for electric service. Of the existing pump stations, the Richland-Chambers intake and Ennis are served by Brazos Electric Power Cooperative, which owns transmission lines connected to the Oncor transmission system. Waxahachie and the Cedar Creek intake are directly connected to Oncor. The proposed Southern Pipeline pump stations would be connected to the Oncor system either directly or through Brazos Electric Power Cooperative. Depending on the final selected pump station sites, other utilities that may be involved include Trinity Valley Electric Cooperative and Johnson County Electric Cooperative. The Lake Palestine site is the exception; it would be connected to the Rayburn County Electric Cooperative 69kV transmission system. This system is not included in the ERCOT system but is rather connected to the Southwest Power Pool (SPP) grid.

Section 4
Operations Modeling

4.1 Purpose and Updates

During the initial comparison of strategic alternatives, a system optimization model was developed to identify opportunities to minimize operational and project development costs (See **Figure 4-1**). The model focused on energy costs, as well as on supply reliability, project phasing, and water sharing potential. A description of the model can be found in the previous report entitled *Summary Report: Project Viability Assessment and Business Case Evaluation of Raw Water Transmission System Integration,* dated July 2008.

Following earlier findings that interconnection offers benefits to both supply systems, the model was refined for comparison of the two integrated conveyance alternatives (**Figure 4-1**). It focused on the following four factors associated with routing Lake Palestine through the TRWD system either through a 3rd Pipeline paralleling the existing lines, or through a Southern Pipeline ("SPL") which would follow a more southerly route to connection points near Joe Pool Lake and Lake Benbrook:

- Supply reliability
- Timing of the Lake Palestine need
- Water sharing ("transfer") potential.
- Phasing potential (described in Section 5)

The model was also used to develop input time series for a steady state hydraulics model of the interconnected transmission system, which is discussed in Section 5 of this report. Updates in the optimization model that helped to refine operational understanding of an interconnected system as well as provide clear output for use in the hydraulics model included:

- Improved resolution on the corridor alternatives, supported by the ongoing corridor analysis presented in Section 2
- Improved application of operating rules, including permitted yield constraints (scenarios were analyzed both with and without these constraints)
- Updated demand projections for DWU (Lake Palestine only) and TRWD (specifically, demands on the West Fork and at Rolling Hills).

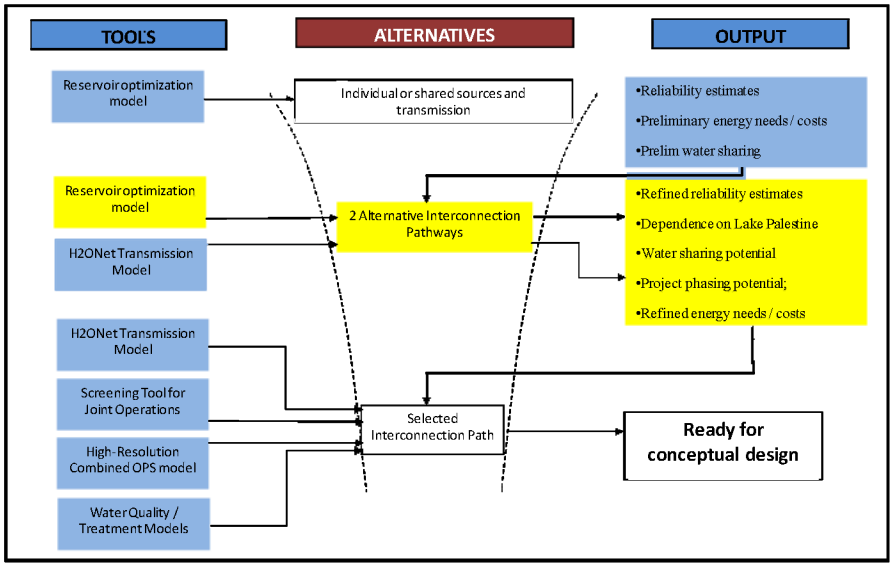

Figure 4-1
Role of the Optimization Model for Comparing 2 Interconnection Alternatives
(Shown in yellow)

Fundamentally, the model was employed to determine if the two routing alternatives for interconnection were substantially different in any of their performance measures, including supply reliability, Lake Palestine timeline, and water sharing potential. The hydraulic model (Section 5) was used to distinguish the two alternatives with respect to energy needs and operating costs.

4.2 Modeling Assumptions

The following assumptions and simplifications were developed to provide a consistent basis of comparison of the two integrated conveyance alternatives, and to yield a model that could distinguish alternatives without the burden of excessive and unnecessary detail.

- The model employs a monthly timestep and results are formulated based on annual averages. For example, a reliable yield during the drought of record is based on the annual flow availability, not potential monthly deficits.

- Firm water needs were defined by simulating the drought of record and existing permitted yield thresholds. A second condition was defined by simulating normal hydrologic conditions and suspending the permitted yield constraints for experimental purposes.

- The system was bounded per **Figure 4-2** to focus on the elements of the systems most directly affected by the new source and conveyance corridors.

- TRWD demand: modeling accounted for all TRWD supplies and demands (customer and terminal storage) but instead of simulating West Fork demands explicitly, they were represented by reducing demand on appropriate nodes within the bounded system in **Figure 4-2**. Hence, West Fork supply and demand is represented implicitly. Demands on the bounded system are summarized in **Table 4-1**.

- Dallas demand: modeling assumed Lake Ray Hubbard yield of 80.1 mgd and linear growth in demand between decadal projections. This results in projected needs for Lake Palestine as follows (also see **Table 4-1**):

  - New supply must be on-line by 2023

  - Full 102 mgd of Lake Palestine by 2042

- Ellis County – full Ellis County demand was accounted for per Region C "Four County Study" (this includes demand which can be partially satisfied with local supplies - Ellis County demand on the interconnected system will therefore be reduced commensurately in future analysis). The "Four County Study" modeling assumptions for TRWD in Ellis County are based on contracted volumes, extending to 2030 and includes supplies from TRWD to meet demand that has not yet been contracted.

- Flow between points connected by more than one pipeline was divided equally between the pipes (on a capacity percentage basis) in order to approximate lowest-cost transmission. For example, deliveries to demand nodes along the Cedar Creek and Richland-Chambers line were divided between the two pipelines such that they carried equal percentages of the respective pipeline capacity.

- No external sources other than Lake Palestine were simulated and hence long-range demand forecasts resulted in simulated water deficits. Deficits in the model were distributed equally by percentage among the following three entities (this assumption will be refined in subsequent work, which will be able to identify location of deficits within each system):

  - DWU

  - TRWD

  - Ellis County (gross demand without consideration of local supplies)

- Demand and permitted yield (including TRWD Wetlands): Analysis was completed with and without the application of permitted yield constraints for the TRWD reservoirs. Permitted yield values (also representing annual safe yield, which would leave water in the reservoirs even during the drought of record) are presented in **Table 4-1**, and results in later sections reflect the significance of these constraints.

- For these sets of analysis, all source water was considered to be available to all users, and the least expensive sources and pathways were tapped first.

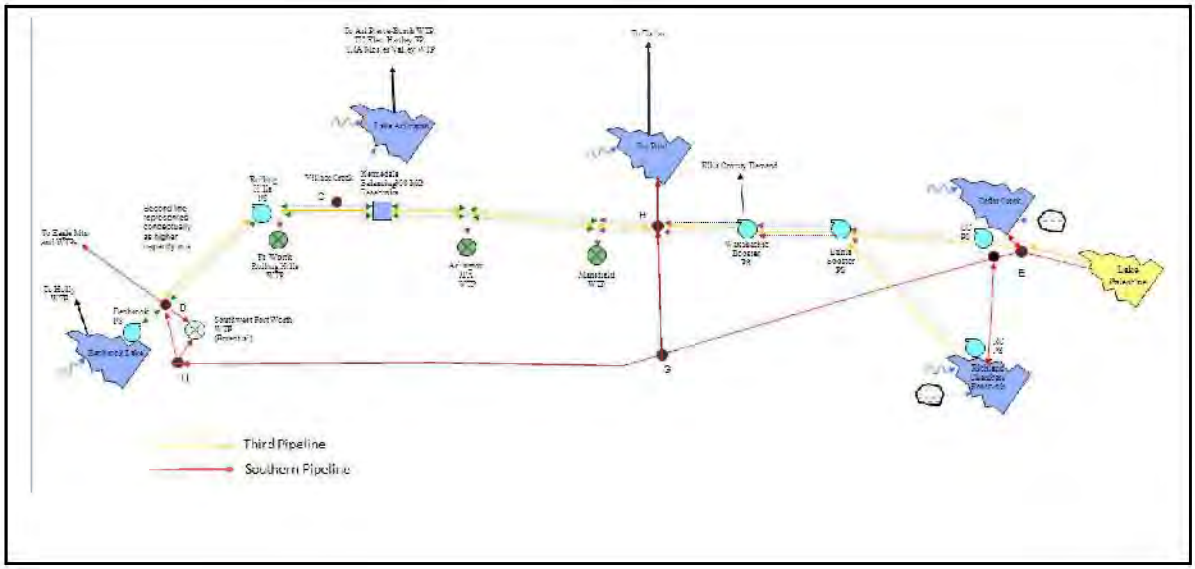

Figure 4-2
Boundaries of Simulated System

Table 4-1
Permitted Supply and Demand Summary

	TRWD and Ellis County							DWU	
	Permitted Yield (mgd)				Average/Max Year Drought Demand (mgd)*			Permitted Yield (mgd)	Avg Drought Demand (mgd)
	RC	CC	Benbrook	Total	TRWD**	Ellis Cty.	Total	Lake Pal	DWU
2020	244	203	65	512	340/401	46	386/447	102	0
2030	244	203	65	512	410/472	60	470/532	102	55
2040	244	203	65	512	466/532	74	540/606	102	102
2050	244	203	65	512	522/592	88	610/680	102	102
2060	244	203	65	512	580/651	104	684/755	102	102

*Average drought demand is computed over the 7-year historical drought of record, while the "Max Year Drought Demand" represents the highest expected annual demand during such a drought.

**TRWD total demand values are reduced by yield from the West Fork, which is not simulated in this analysis, and which is approximately 89 mgd during normal periods, 41 mgd during severe droughts.

4.3 Supply Reliability

The first set of tests conducted with the model were to determine if either of the two integrated conveyance alternatives offered a distinguishable benefit in supply reliability over the other. This was tested both with the application of annual permitted withdrawal constraints from **Table 4-1** along with the drought of record and, experimentally, with the suspension of these annual thresholds (which results in more source water availability) and simulation of normal hydrology.

Figure 4-3 illustrates the results of the analysis. Fundamentally, neither of the two routing alternatives distinguishes itself as superior to the other with respect to supply reliability. Both can satisfy nearly 100% of the total annual system demand through 2030, and both decline to satisfy approximately 70% of total demand by 2060. Clearly, this decline reflects limitations in supply and permitted withdrawals, as scenarios with average hydrologic conditions and suspended permit constraints reveal sufficient water in the system to satisfy nearly all of the demands through 2060.

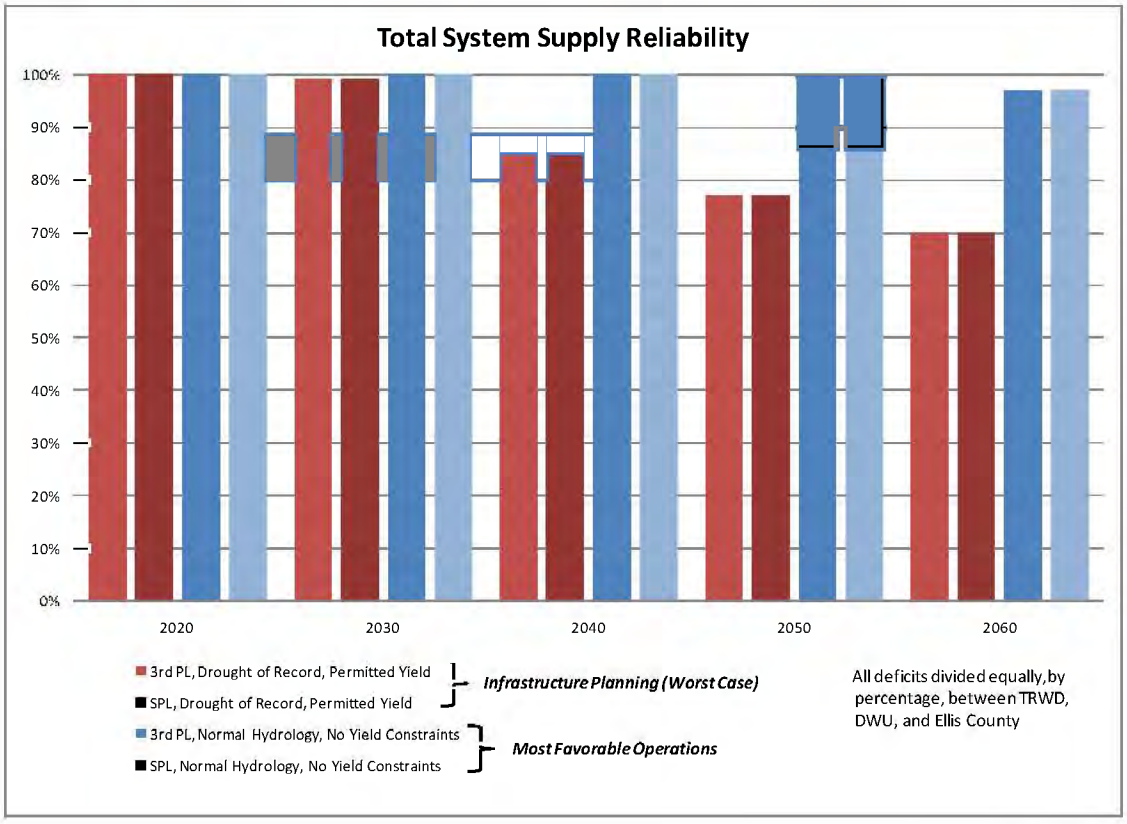

Figure 4-3
System Supply Reliability

4.4 Use of Lake Palestine

In the same way that the model was used to quantify supply reliability with and without the permitted yield constraints, it was helpful in identifying the need for Lake Palestine water in future decades. Firm planning needs were defined with the application of permitted yield constraints and the simulation of the drought of record. "Most favorable" conditions were simulated with normal hydrologic conditions and the suspension of permitted yield constraints (experimentally).

Figure 4-4 illustrates that the firm need for Lake Palestine would begin between 2020 and 2030, but it would not need to produce water at the contract capacity (102 mgd) until approximately 2040. During normal hydrologic periods, and with permitted yield constraints of other TRWD reservoirs experimentally suspended, the existing reservoirs could satisfy projected demand through 2060 without Lake Palestine.

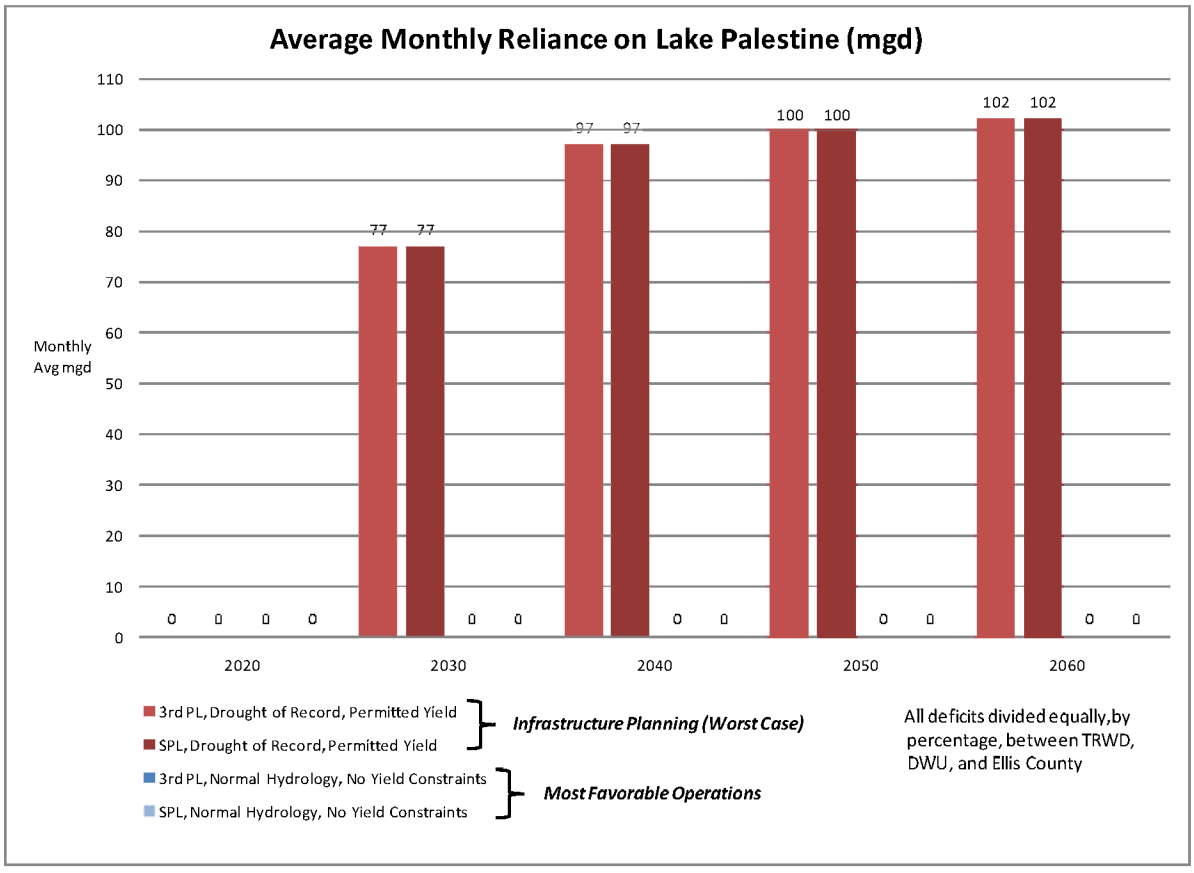

Figure 4-4
Dependence on Lake Palestine Water

4.5 Water Sharing Potential

The potential to share water sources through the integrated conveyance has been assumed to be a consistent opportunity throughout the scenarios presented to this point. The analysis was conducted on the system as a whole, without restricting agency access to specific source water bodies. This section quantifies the potential for water supply sharing between Dallas and TRWD by decade.

Figures 4-5 and 4-6 illustrate the gaps between both system's demands and water availability from their respective sources through 2060. In accordance with the bounded nature of the subsystem most directly affected by Lake Palestine interconnection, Lake Palestine is the only source considered for DWU in this analysis. Effectively, where demand is less than permitted supply, an opportunity exists to provide the volume of water equivalent to the gap to the other system.

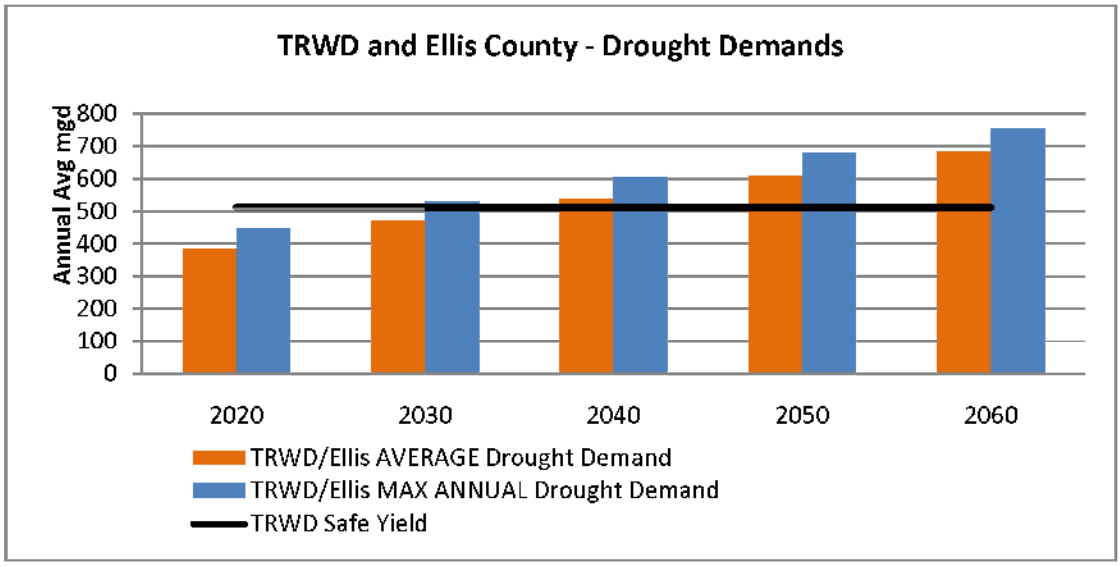

Figure 4-5
Supply vs. Demand for TRWD and Ellis County
Note: Safe Yield includes Richland-Chambers Reservoir, Cedar Creek Reservoir, and Lake Benbrook (and does not include the West Fork reservoirs)

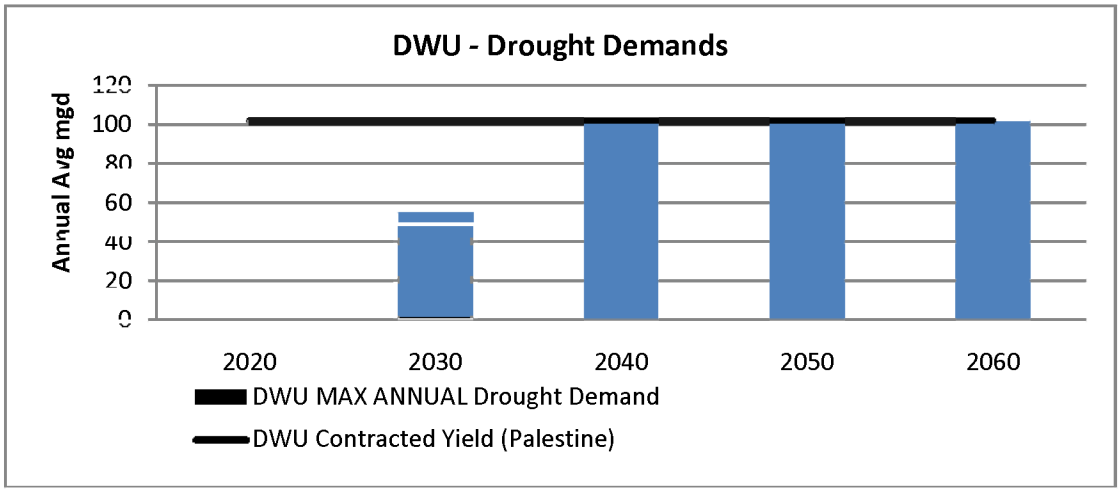

Figure 4-6
Supply vs. Demand for DWU at Lake Palestine

Note: In **Figures 4-5 and 4-6**, "Average drought demand" is computed over the 7-year historical drought of record, while the "Max Annual Drought Demand" represents the highest expected annual demand during such a drought.

Summary of Sharing Opportunities Under Firm Yield Conditions

The following summary focuses on results obtained by simulating the drought of record in conjunction with permitted yield thresholds. **Table 4-2** summarizes opportunities for water sharing between the two systems.

2020: DWU is not expected to need water from Lake Palestine in 2020. However, even during the most extreme drought year, the TRWD system could have 65 mgd that could be made available to DWU. Alternatively, 102 mgd from Lake Palestine could be available to TRWD through 2023, when DWU demand begins to ramp up until in 2040, 0 mgd would be available to TRWD.

2030: DWU may have 47 mgd available from Lake Palestine, while TRWD could face a deficit of 20 mgd during the most extreme drought year. Hence, DWU could provide 47 mgd on a reliable basis to TRWD. However, TRWD supply planning anticipates development of additional supplies prior to 2030.

2040 – 2060: From 2040 onward, both systems project demand that eliminates water sharing potential under firm yield conditions. See below, however, for opportunities under normal hydrologic conditions.

Summary of Opportunities to Share Water under Normal Hydrologic Conditions

Analysis to this point has been based on deliveries and demands projected on normal hydrologic conditions and the historical 7-year drought of record. Under normal hydrologic conditions, there are greater opportunities for water sharing, though they should be viewed only as operational opportunities, not firm commitments.

Table 4-2 summarizes opportunities for water sharing between the two systems. The summary includes opportunities during normal hydrologic periods, as well as firm commitments that could be made based on the historical drought of record.

Table 4-2
Water Transfer Potential

All flows in mgd	2020*		2030*		2040*		2050*		2060*	
	TRWD to DWU	DWU to TRWD	TRWD to DWU	DWU to TRWD	TRWD to DWU	DWU to TRWD	TRWD to DWU	DWU to TRWD	TRWD to DWU	DWU to TRWD
Available with normal hydrology**	102+	102	102	102	102	102	102	102	102	102
Avg. Avail during Drought of Record	126	102	42	47	0	0	0	0	0	0
Available during worst drought year	65	102	0	47	0	0	0	0	0	0

*Columns are either/or for any given month

Normal hydrology scenarios also are **not constrained by permitted yield. Values are capped at 102 even though more may be available from TRWD to DWU.

4.6 Conclusions from Operations Modeling

The operations model was intended to identify upper bounds on the opportunities to realize benefits of system interconnection, and also to help identify any substantial performance differences between the two integrated conveyance alternatives (with the exception of costs, which were covered with separate analyses). The following conclusions can be drawn from this analysis:

- There are no significant performance differences between the two integrated conveyance alternatives (reliability, dependence on Lake Palestine, and water sharing potential).
- Reliability:
  - Both provide ~100% firm reliability (on an annual average basis) up to 2030 (under all hydrologic conditions)
  - Beyond 2030, firm reliability < 100% (source water supply in addition to the confined system would be needed to satisfy demand fully)
- Lake Palestine Needs (Firm planning basis):
  - No demand on Lake Palestine before 2020
  - Partial capacity needed by 2030 (~75 mgd)
  - Full capacity needed by 2040 (102 mgd)
- Firm Water Sharing Potential
  - 2020: up to 65 mgd to DWU or up to 102 mgd to TRWD
  - 2030: up to 47 mgd to TRWD
  - 2040 – 2060: No reliable sharing potential without additional supply sources

Section 5
Pipeline Phasing Opportunities

5.1 Goals of Phasing Study

The purpose of this analysis was to identify opportunities to defer the construction of portions of the integrated conveyance alternatives to potentially spread associated capital costs over time. Results were obtained by removing sections of pipeline from the operations model described in Section 4, and then simulating drought conditions. These results therefore identify opportunities for phasing based on water supply reliability under a specific set of assumed conditions (drought of record in the 1950's, connection of TRWD constructed wetlands, etc.) and do not consider other factors that weigh in the decision to defer construction of pieces of the conveyance system.

While there may also be opportunities to construct or expand pump stations incrementally over time, this analysis focused mainly on the pipeline reaches, assuming that the opportunities for cost savings would be more substantial with respect to the pipeline. Certainly, additional opportunities exist, but this analysis was conducted at a macro-scale for the sake of differentiating the conveyance alternatives.

Two operating conditions were used in this comparison; full reliability and the acceptance of a small reliability risk. Both are discussed below. Phasing scenarios are compared against a baseline construction scenario which produces a complete pipeline by 2018.

5.2 Phasing for Full Reliability

The system was first evaluated to examine phasing strategies that would not reduce the firm supply reliability estimates presented in Section 3. Since it is estimated that Lake Palestine water supply would not be needed by the City of Dallas on a firm basis until 2023, both integrated conveyance alternatives could defer the connection of Lake Palestine to Cedar Creek Reservoir until then, thereby spreading approximately $200M over a slightly longer period than would be required if the full pipeline from Lake Palestine to western Tarrant County were completed by 2015.

The 3rd Pipeline offers one additional opportunity for phased implementation, which is the connection between the Rolling Hills WTP and Lake Benbrook. This connection could conceivably be deferred until 2030, thereby deferring approximately $300M an additional 15 years.

As currently envisioned, the Southern Pipeline does not offer the flexibility to defer the connection to Benbrook. Deferring completion until 2030 could create potential for water shortages at Mansfield WTP, Arlington WTP, Lake Arlington, and Rolling Hills WTP. The Southern Pipeline delivers less water to the DWU takeoff (represented as Joe Pool Lake in this analysis, but will more likely lead to the Bachman WTP) than does the 3rd Pipeline under future peak conditions. Without the connection between Rolling Hills WTP and Lake Benbrook, the 3rd Pipeline could still

supply needed water to these demand nodes, while it is unlikely that demand could be fully supplied with the Southern Pipeline. The 3rd Pipeline would deliver 325 mgd to the Joe Pool takeoff point, leaving almost 200 mgd *and conveyance capacity* for TRWD demand nodes downstream to Rolling Hills after DWU withdrawals. The Southern Pipeline would deliver only 128 mgd to the Joe Pool takeoff point, leaving no additional water or conveyance capacity to the demand nodes from Mansfield WTP to Rolling Hills WTP (See **Figure 5-1**). While approximately 200 mgd conveyance capacity would be available to backflow from Benbrook to Rolling Hills via the Southern Pipeline, this capacity would be of little use on a firm basis if the Southern Pipeline was not completed all the way to Benbrook to close the backflow loop.

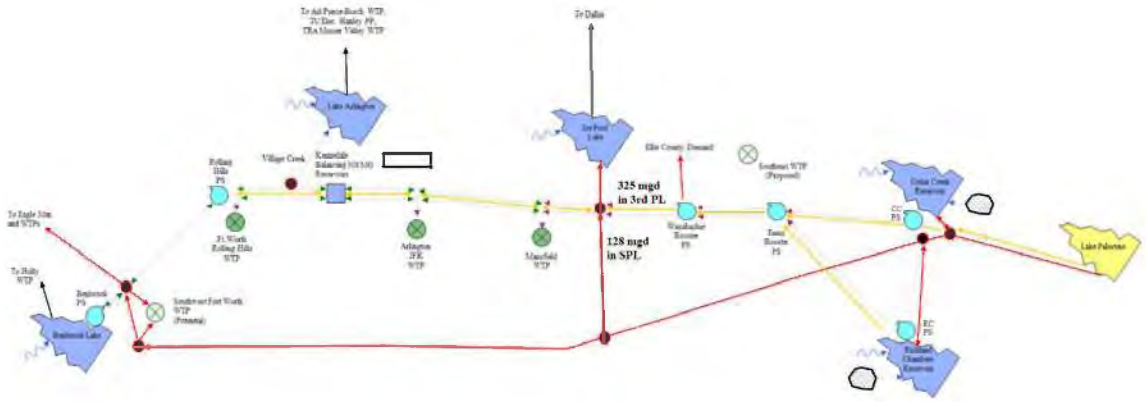

Figure 5-1
Impacts of Deferring Additional Connection between Rolling Hills and Benbrook

5.3 Phasing with Small Supply Risk

The above analysis suggests phasing opportunities that would not reduce the ability of the system to provide the supply reliability performance estimated in Section 3. However, with the acceptance of a small risk, additional phasing opportunities could be considered. Additional external supplies will reduce or eliminate the risk of water deficits.

The following alternatives could be considered, and are summarized in **Figure 5-2**:

- Third Pipeline
  - Defer Palestine to Cedar Creek connection (approx. $200M) to completion by 2023
  - Defer Joe Pool (Bachman takeoff) to Lake Benbrook connection (approx. $350M)
    - Connect to Kennedale by approximately 2025

- Connect to Benbrook by approximately 2035

- Southern Pipeline
  - Defer Palestine to Cedar Creek connection (approx. $200M) to completion by 2023
  - Defer Joe Pool (Bachman takeoff) to Lake Benbrook connection (approx. $300M) to completion by 2025

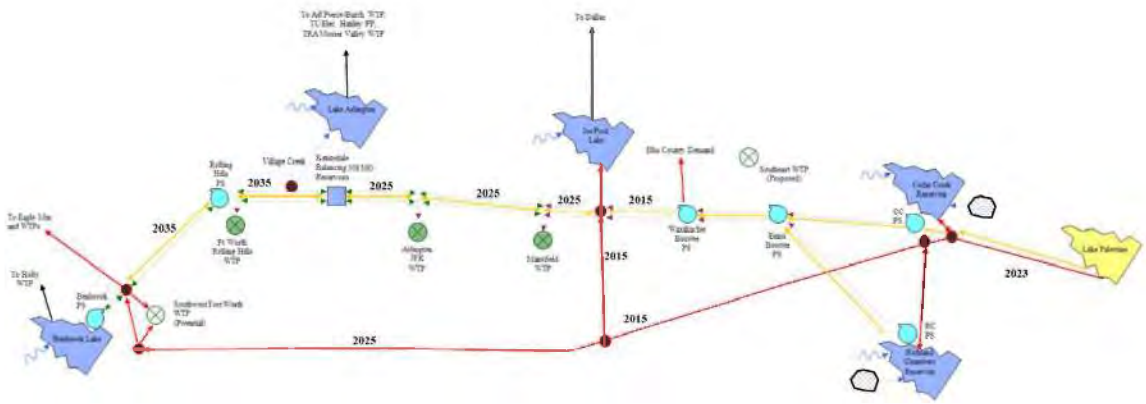

Figure 5-2
Potential Timing of Pipeline Segments with Small Reliability Risk

5.4 Phasing Conclusions

Figure 5-3 summarizes the analysis of phasing potential for the two integrated conveyance alternatives. Generally, the 3rd Pipeline offers greater flexibility with phasing opportunities because, as currently sized, it would deliver substantially more water to a Dallas delivery point, and would offer greater downstream conveyance to four TRWD demand nodes even without going initially to Benbrook. That is, after DWU takes its allocated water from the system, the 3rd Pipeline would still be able to supply and convey 200 mgd (approximately) to TRWD demand nodes.

Opportunities for phasing in the Southern Pipeline alternative are more limited because there is not adequate capacity in the existing East Texas pipelines to deliver additional water from the location of the blind flange at Joe Pool Lake (where the Southern Pipeline would deliver additional water to the existing pipelines) to TRWD demand nodes farther west.

All of these scenarios were evaluated conceptually, and more detailed daily operating scenarios continue to be evaluated in the TRWD-Dallas RiverWare model.

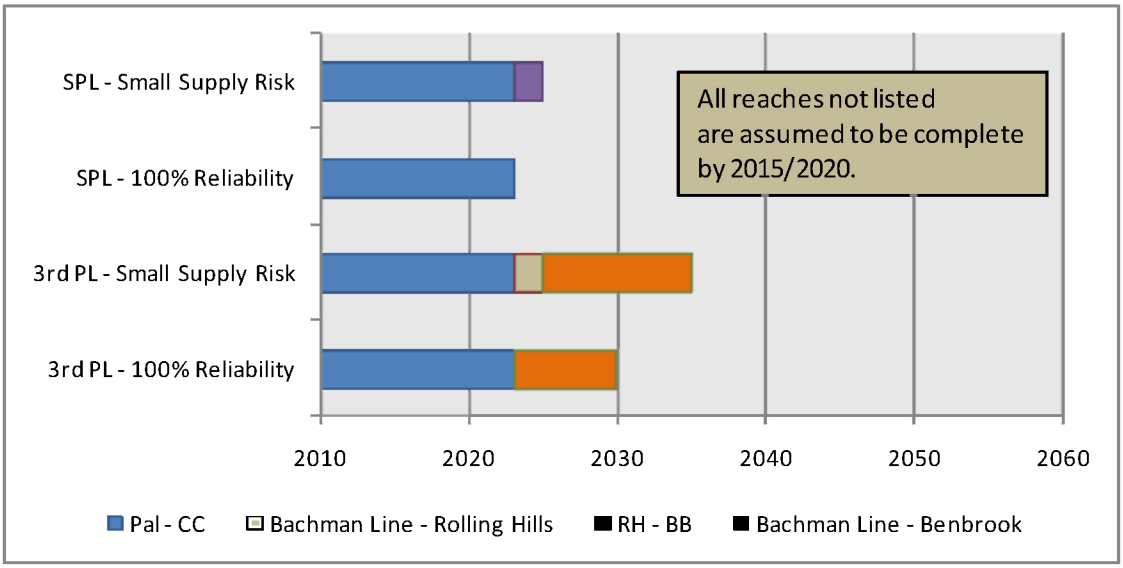

Figure 5-3
Potential Phasing Summary (Firm Supply Reliability Analysis)

Section 6
Hydraulic Modeling

6.1 Introduction and Approach

The purpose of this section is to describe the hydraulic modeling effort as defined in Task 1.4 of Phase I, Amendment 2 of the Raw Water Transmission System Integration Study. The primary objectives of this analysis are to support development of a recommended conveyance alternative by:

1. Refining the energy usage assessment and developing updated operational costs estimates for the Southern and Third Pipeline interconnected conveyance alternatives; and

2. Calculating preliminary infrastructure sizes (pipe diameter and pump station horsepower).

Hydraulic modeling of the Southern and Third Pipeline alternatives includes the system as bounded by Figure 4-2 in Section 4 of this report. Existing transmission lines were included to examine alternative flow-splitting strategies. The purpose of the model was to determine operational cost estimates using a long-term simulation of flow transmission; day-to-day operations of the integrated conveyance system are not formulated.

The hydraulic modeling software used in this study is MWH Soft's H2ONET, an interactive water distribution system modeling tool that runs within AutoCAD. H2ONET is in essence a pre- and post-processor for the EPANET engine. TRWD provided CDM with two existing hydraulic models, one developed in H2ONET and the second in EPANET. Though the EPANET model has a current representation of existing TRWD system hydraulics, the model does not include portions of the transmission network that are required for this analysis; those missing system pieces were included in the H2ONET model. However, the H2ONET model was not representative of the most current system hydraulics. Using TRWD's recommendation, modeling for this phase of the project is carried out using the existing H2ONET model with updates to the system hydraulics incorporated based on the EPANET model.

A hydraulic model was created for the two primary interconnected conveyance alternatives – the Southern Pipeline and the Third Pipeline (see Figure 1-3). Because the purpose of this analysis is to compare these two primary corridors, only one of the two Southern Pipeline alternatives is modeled here. The Southern "Rural" Pipeline corridor is selected for hydraulic analysis because it represents a larger contrast to the Third Pipeline from a hydraulics perspective.

Fundamental components of the modeling approach are summarized below:

- Average annual energy cost estimates are derived through simulation of monthly flows over a 7-year period of average hydrologic conditions;
- Monthly demands and reservoir operations are based on results from the Operations Model (as described in Section 4);
- Model flows are driven by demand nodes (WTP's);
- Pump station horsepower and system energy usage are calculated from the total dynamic head in each conveyance segment over the course of a 7-year simulation.

6.2 Assumptions and Criteria

Data used in the hydraulic model was obtained from the existing H2ONET and EPANET models and from TRWD and DWU (updated pump curves, pipeline capacity, and other data regarding operational principles of the existing transmission system). Section 2 of this report details criteria and standards used in this project; below is a list of criteria specific to the hydraulic model.

- Proposed pipes are sized based on peak design flow velocity of 8 feet per second (peak to average flow factor of 1.25) and maximum working pressure of 200 psi.
- Existing pipe capacities and pressures are defined by TRWD for existing pipelines (see Table 2-2 in Section 2 of this report):
  - Cedar Creek Line: Cedar Creek Reservoir to Ennis booster pump station (BPS)
  - Richland-Chambers Line: (Richland-Chambers Reservoir to Ennis BPS)
  - Parallel Lines: (Ennis BPS to Kennedale Balancing Reservoir)
  - Kennedale to Rolling Hills Water Treatment Plant (WTP)
  - Rolling Hills WTP to Lake Benbrook
- The H2ONET model is run using the Darcy-Weisbach friction factor option.
- Electricity is assumed to be supplied from the existing transmission system and therefore all pumps are assumed to be configured with Variable Speed Drives (either presently or upgradable).
- A firm yield criterion is applied to reservoir operations in the hydraulic model. Reservoir yields (permitted annual and peak values) used in the hydraulic model are shown in **Table 6-1** (more detail provided in Table 2-2 in Section 2 of this report). Permitted yield values are assigned as reservoir supplies to the model and peak values are used to size the transmission system.

Table 6-1
Reservoir Yields used in the Hydraulic Model

	Lake Permit (Average Annual) (ac-ft/yr)	Wetlands (Average Annual) (ac-ft/yr)	Total Average Annual (ac-ft/yr)	Total Peak* (ac-ft/yr)	Total Peak (1.25 factor) (MGD)
Cedar Creek Reservoir	175,000	52,500	227,500	284,375	254
Richland-Chambers Reservoir	210,000	63,000	273,000	341,250	304
Lake Palestine	114,337	n/a	114,337	224,200	153 to CC, 128 beyond

- **Table 6-2** contains data on the existing TRWD transmission system capacity from Cedar Creek and Richland-Chambers Reservoirs to the west, and the calculated additional capacity needed to convey "new water" from the constructed wetlands and Lake Palestine.

Table 6-2
Peak Capacities used in Hydraulic Model

	Existing System Peak Capacity @ 8fps (MGD)	Proposed Peak† Capacity (CC/RC/Constructed Wetlands Yield + Palestine) (MGD)	Additional Peak† Capacity Needed to Convey "New Water" (MGD)
Palestine to Cedar Creek	n/a	153	153
Cedar Creek Line (CC to Ennis)	127*	382 (128 Pal + 254 CC)	255
Richland Chambers Line (RC to Ennis)	246	316	76
Combined (Ennis to Kennedale)	373	698 (382 + 316)	325
Kennedale to RH WTP	127 + 228 = 355, 225 reverse flow		
RH WTP to Benbrook	110 Gravity, 200 with RHBPS, 225 reverse flow		

**Note: At 8 fps capacity is 146 MGD. Actual system constraints limit this value to 127 MGD.*

***Note: Used 244 in Phase 1 Ops Model*

†Note: 1.25 peaking factor

- Existing pump capacities are shown in **Table 6-3**. The difference between values in Table 6-3 and Table 6-2 represents the additional pumping capacity needed.

Table 6-3
Existing Pump Capacities

Pipeline/Segment	Design Pumping Rate	Maximum Allowable Pumping Rate	Comments
Cedar Creek			
Lake to Waxahachie	70 mgd	68 mgd	Minor limitation
Lake to Ennis	134 mgd	129 mgd	Limited by allowable pipe pressure rating in low lying area west of Lake PS
Ennis to Waxahachie	134 mgd	127 mgd	Limited by allowable pipe pressure rating in the eastern half of this line segment
Waxahachie to Balancing Reservoir	134 mgd	129 mgd	Major limiting sections replaced
Richland Chambers			
Lake to Waxahachie	148 mgd	141 mgd	Minor limitation
Lake to Ennis	249 mgd (2020)	247 mgd	Minor limitation
Ennis to Waxahachie	249 mgd (2020)	246 mgd	Minor limitation
Wax to Bal Reservoir	249 mgd (2020)	247 mgd	Pipe pressure limitation west of Mansfield Tap will be corrected before 2010

- Friction factors used in each pipeline in the hydraulic model are listed in **Table 6-4**. Pipe material in the proposed pipelines will likely vary between steel in urban settings and PCCP in rural settings. In this hydraulic analysis, the friction factor is assumed to be equivalent for both pipe materials.

Table 6-4
Friction Factors of Existing and Proposed Pipelines in the Hydraulic Model

Pipeline	Pipe Condition	Friction Factor	Absolute Roughness (feet)
Cedar Creek			
Existing 72-inch	Existing, Deteriorated	0.019	0.005
Relined	Reconditioned	0.014	0.001
Proposed 90-inch	Mid Term	0.012	0.0005
Richland-Chambers			
Existing 90-inch	Existing	0.016	0.003
Proposed 60-inch	Mid Term	0.012	0.0005
Third/Southern Pipeline (108-inch)	Mid Term	0.011	0.0004

- Hydraulic modeling was performed for a 7-year period of average hydrologic conditions.
- Proposed pump curves used in the hydraulic model (for additional pumps in existing pump stations and pumps in new pump stations) are based on existing pump curves. The following curves are used to represent each pumping station:
  - Cedar Creek Intake Pump Station Curve
    - Palestine Intake PS
    - Existing Cedar Creek Intake PS
    - Proposed Cedar Creek Intake/BPS
    - Rolling Hills Booster PS
  - Richland-Chambers Pump Curve: Richland-Chambers Intake PS
  - Ennis BPS: Ennis Pump Station
  - Waxahachie BPS: Waxahachie Pump Station
  - Southern Pipeline BPS's: used existing Waxahachie BPS curves
- For the Phase I, Amendment 2 hydraulic analysis, some simplification of existing system operations are incorporated to support long-term simulations (to be refined in future phases of design).

- Kennedale Balancing Reservoir: operation of the balancing reservoir (250 to 300 MG of storage) is not included in the hydraulic model, but the facility elevation is included to account for impacts on head loss and total dynamic head.

- Low/High Capacity Operations: TRWD currently operates pumps from Cedar Creek and Richland-Chambers Reservoirs to the Waxahachie Booster Pump Station (BPS) in two modes. Under low flow conditions (less than 150 MGD in Richland-Chambers line and 76 MGD in Cedar Creek line) the Ennis BPS is not needed; above this threshold Ennis BPS is utilized. The hydraulic model currently does not differentiate between high and low capacities and uses both Ennis BPS and Waxahachie BPS to generate the required dynamic head. Because tariff structures are not applied in the hydraulic model, this does not change the cost of energy usage; this analysis calculates gross energy usage.

- Longitudinal ground profiles used to represent the interconnected Third Pipeline and Southern Pipeline alternatives are shown in **Figure 6-1**.

6.3 Results

This section explains results for the hydraulic modeling analyses: transmission system infrastructure sizing and energy usage estimates. All model simulation runs are performed using a daily time-step and using output from the operations model (see Section 4) runs for each decade from 2020-2060; reservoir yield values used in the operations model are assigned to the hydraulic model. Flow apportionment logic (between pipelines) developed in the operations model is used to drive the pump station control logic in the hydraulic model. Flows delivered at each demand node in the operations model are assigned to demand nodes in the hydraulic model.

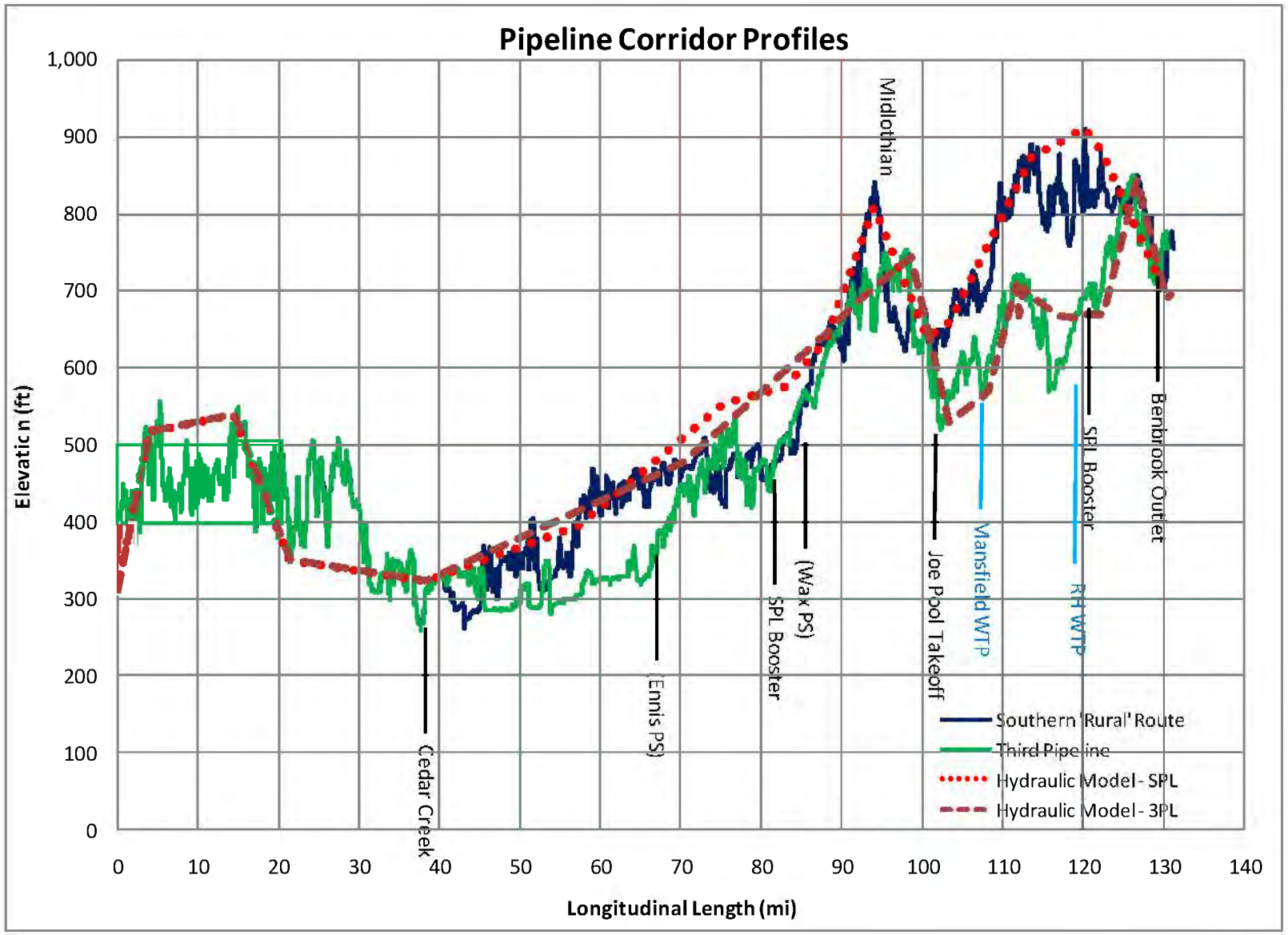

Figure 6-1
Pipeline Corridor Profiles used in Hydraulic Model

6.3.1 Transmission System Sizing

A simulation for each segment is used to calculate preliminary sizes of transmission system infrastructure. Each segment is assigned a demand that could be conveyed while satisfying a velocity requirement of 8 feet per second and a pressure rating of 200 psi. Pump types and pumping capacities of the proposed transmission system are determined by subjecting each pump station to the peak capacity requirement for pipelines associated with the pump station. Total dynamic head results from the hydraulic model are then used to determine locations of proposed pump stations. Proposed pump curves are assumed to be similar to existing pumps at the same location.

A detailed description of transmission system sizes is provided in Appendix A and summarized below in **Table 6-7**. A comparison of existing, Interconnected Third Pipeline, and Interconnected Southern Pipeline system pumping capacity (in terms of horsepower) is presented in **Table 6-8**. Comparing the pumping capacities of the existing and proposed systems, it can be concluded that the pumping capacities required by the proposed system are approximately twice the amount provided in the existing system and horsepower requirements of the Third Pipeline and the Southern Pipeline alternatives are similar (2.5% difference).

Table 6-7
Preliminary Infrastructure Sizing

Alternative	Segment	Diameter (inches)	Design Flow (mgd)	Length (mi)
Southern Corridor-Rural Alignment	Palestine to Cedar Creek	78	153	38.3
	Cedar Creek to Joe Pool Turnout	108	325	62.5
	Joe Pool Turnout to Benbrook	84	197	28.3
	Southern Corridor (Rural Alignment) - Turnout on SPL to Joe Pool	72	128	7.4
	Southern Corridor- RC to CC Alignment	54	70	12.2
Southern Corridor-Urban Alignment	Palestine to Cedar Creek	78	153	38.3
	Cedar Creek to Joe Pool Turnout	108	325	64.4
	Joe Pool Turnout to Benbrook	84	197	24.5
	Southern Corridor (Urban Alignment) - Turnout on SPL to Joe Pool	72	128	1.6
	Southern Corridor- RC to CC Alignment	54	70	12.2
Third Pipeline	Palestine to Cedar Creek	78	153	38.3
	Cedar Creek to Ennis	96	255	32.3
	Ennis to Joe Pool Turnout	108	325	32.3
	Joe Pool Turnout to RHWTP	84	197	16.3
	RHWTP to Benbrook	84	197	9.2
	RC to Ennis Alignment	54	70	29.7
Connections	Joe Pool to Bachman WTP	78	128	27.8

Table 6-8
Comparison of System Pumping Capacity

Modeled System Existing Pumping Capacity		Modeled System Pumping Capacity – Third Pipeline Alternative		Modeled System Pumping Capacity – Southern Pipeline Alternative	
Segment	Total HP	Segment	Total HP	Segment	Total HP
CC Intake	18,000	CC Intake	45,000	CC Intake	45,000
RC Intake	16,500	RC Intake	49,500	RC Intake	49,500
Ennis - CC Line	15,000	Ennis - CC Line	15,000	Ennis - CC Line	15,000
Wax - CC Line	15,000	Wax - CC Line	15,000	Wax - CC Line	15,000
Ennis - RC Line	25,000	Ennis - RC Line	55,000	Ennis - RC Line	25,000
Wax - RC Line	25,000	Wax - RC Line	55,000	Wax - RC Line	25,000
Rolling Hills PS	18,000	Rolling Hills PS	24,000	SPL PS (near Wax)	30,000
Total (Existing)	**132,500**	Palestine Intake	18,000	SPL PS (near BB)	25,000
		Total (proposed)	**258,500**	Rolling Hills PS	18,000
				Palestine Intake	18,000
				Total(proposed)	**265,500**

6.3.2 Energy Usage

Twelve model simulations are completed for the interconnected system: six runs correspond to the Interconnected Third Pipeline alternative and six correspond to the Interconnected Southern Pipeline alternative. Simulations are based on supply/demand data for a seven-year period representing each of the decades 2020, 2030, 2040, 2050, and 2060 respectively. Demand data used in the hydraulic model runs are listed in Appendix B. Flow and total dynamic head results for each of the six decadal runs are exported for post-processing of cost calculations.

Horsepower is calculated using a wire to water efficiency of 65%, which is slightly less than the value of 67.5% used in the previous phase of work (90% Motor Efficiency and 75% Pump Efficiency). An average value of 8 cents per KWh is used to determine the energy costs.

Table 6-9 presents the details of average flows delivered and operational costs in each decade. Results presented in this table are used to compare energy costs incurred for the Third Pipeline and Southern Pipeline as part of the preferred alternative selection process.

Table 6-9
Comparison of Hydraulic Model Simulation of Third Pipeline and Southern Pipeline Alternatives

	3rd PL - HYD Model				SPL - HYD Model			
Year	Delivered Avg (MGD)	$M/Yr	$M/mgd	$/kgal	Delivered Avg (MGD)	$M/Yr	$M/mgd	$/kgal
2020	299	$23	0.08	$0.21	298	$24	0.08	$0.22
2030	429	$36	0.08	$0.23	425	$37	0.09	$0.24
2040	538	$51	0.09	$0.26	526	$49	0.09	$0.26
2050	593	$57	0.10	$0.26	571	$56	0.10	$0.27
2060	642	$65	0.10	$0.28	604	$62	0.10	$0.28

A detailed review of model results for the Third Pipeline and Southern Pipeline alternatives leads to the conclusion that the difference in energy usage/cost between the two alternatives is not significant enough at this level of detail to select between the alternatives based solely on this criterion, and that any difference would only be apparent with more detailed and extensive modeling of both alternatives to replicate existing system operations, and analyze proposed system hydraulics. It does suggest lower overall operational costs compared to analysis completed in the previous project phase. **Table 6-10** summarizes the total cost for the individual alternatives and the average of the cost obtained for the two alternatives. The plot shown in **Figure 6-2** represents the trends in the average annual operational costs over the modeling period.

Table 6-10
Average Annual Energy Cost based on Hydraulic Modeling

Decade	3rd PL - HYD Model	SPL - HYD Model	Average
	$ M/Yr	$ M/Yr	$ M/Yr
2020	$23	$24	$24
2030	$36	$37	$37
2040	$51	$49	$51
2050	$57	$56	$58
2060	$65	$62	$66

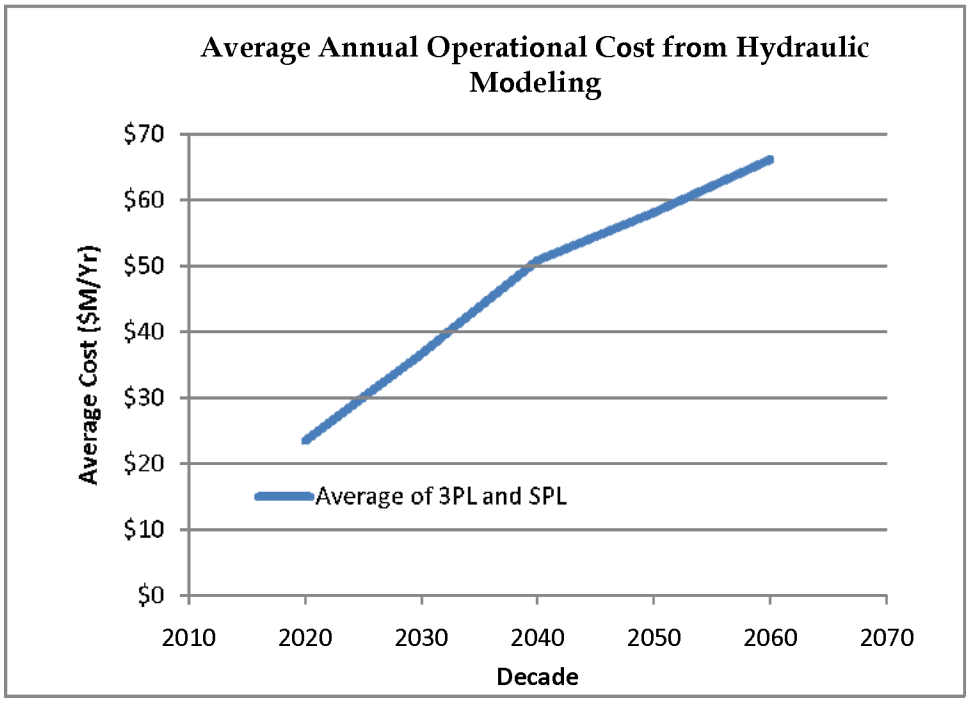

Figure 6-2
Average Annual Operational Costs from Hydraulic Modeling

Section 7
Cost Analysis

This section describes the project cost analysis history and the current basis for the feasibility/conceptual level opinion of probable capital cost and life cycle cost.

7.1 Phase 1 Cost Analysis Results

These results were documented previously and are repeated here to present a complete picture in this document of the cost analysis history. Below is a list of alternatives analyzed in Phase 1:

Alternative	Description
1 (Baseline)	Independent Systems: TRWD's East Texas Third Pipeline and DWU's connection of Lake Palestine to the proposed Southeast Water Treatment Plant
2 (Baseline)	Independent Systems: TRWD's East Texas Third Pipeline and DWU's connection of Lake Palestine to Joe Pool Lake
3 (Interconnection)	Integrated System: Interconnected Third Pipeline (upsized as compared to the baseline condition) with connection of Lake Palestine to Cedar Creek Reservoir and delivery to DWU at Joe Pool Lake and TRWD's customers through the Third Pipeline
4 (Interconnection)	Integrated System: Interconnected "Southern Pipeline" - Lake Palestine delivered to the Lake Benbrook pipeline via a pipeline route to the south of the TRWD Third Pipeline route. Delivery to DWU at Joe Pool Lake and TRWD's customers through connections to the existing system and the Lake Benbrook pipeline.

Results of Phase 1 capital cost analysis:

Baseline Alternatives	Capital Cost (2008 basis)
Alternative 1: TRWD Third Pipeline + DWU Lake Palestine to SE WTP	$1,177,844,000
(Component 1: DWU Lake Palestine to SE WTP)	(548,949,000)
(Component 2: TRWD Third Pipeline)	(628,894,000)
Alternative 2: TRWD Third Pipeline + Lake Palestine to Joe Pool Lake	$1,303,360,000
(Component 1: DWU Lake Palestine to Joe Pool Lake)	(674,466,000)
(Component 2: TRWD Third Pipeline)	(628,894,000)
Interconnection Alternatives	
Alternative 3: Interconnected Third Pipeline	$1,083,966,000
Alternative 4: Interconnected Southern Pipeline	$1,355,279,000

Results of Phase 1 life cycle cost analysis:

Baseline Alternatives	Total Cost (50-year Life)	Present Value Cost
Alternative 1: TRWD Third Pipeline + DWU Lake Palestine to SE WTP	$6,043,044,000	$2,462,651,000
(Component 1: DWU Lake Palestine to SE WTP)	(2,738,178,000)	(1,198,104,000)
(Component 2: TRWD Third Pipeline)	(3,304,866,000)	(1,264,547,000)
Alternative 2: TRWD Third Pipeline + Lake Palestine to Joe Pool Lake	6,774,762,000	$2,776,834,000
(Component 1: DWU Lake Palestine to Joe Pool Lake)	(3,469,896,000)	(1,512,287,000)
(Component 2: TRWD Third Pipeline)	(3,304,866,000)	(1,264,547,000)
Interconnection Alternatives		
Alternative 3: Interconnected Third Pipeline	5,578,924,000	2,238,879,000
Alternative 4: Interconnected Southern Pipeline	6,306,874,000	2,740,189,000

Comparisons between Phase 1 baseline alternative and interconnected alternative results:

Interconnection Alternative	Comparison Baseline Alternative	Total Cost Difference	Present Value Cost Difference
3 (Interconnected Third Pipeline)	1 (w/ Pal. to SE WTP)	$464,120,000	$223,771,000
3 (Interconnected Third Pipeline)	2 (w/ Pal. to Joe Pool)	1,195,837,000	537,954,000
4 (Interconnected Southern Pipeline)	1 (w/ Pal. to SE WTP)	$-263,830,000	$-277,538,000
4 (Interconnected Southern Pipeline)	2 (w/ Pal. to Joe Pool)	467,887,000	36,644,000

7.2 Phase 1 Amendment 1 Cost Analysis Results

These results were documented previously and are repeated here to present a complete picture in this document of the cost analysis history. The purpose of Amendment 1 was to consider additional cost and treatment implications for transmission of raw water to DWU treatment and distribution system facilities from project conveyance Alternatives 1 and 3, which respectively represent the independent and interconnected raw water transmission system. These additional

treatment and water transmission facilities that may be required for a fully functional integrated strategy for DWU were beyond the initial study boundary; therefore, costs implications in this section are additive to the DWU project conveyance alternative costs. These costs do not include distribution system improvements needed downstream of the water treatment plants.

Results	DWU Scenario		
	1 Bachman WTP	2 Southeast WTP	3 WTP at Joe Pool
Conveyance Capital Cost[1]	$171,132,000	n/a	n/a
Treatment Infrastructure Capital Cost	No Cost at Bachman WTP + Elm Fork Expansion (~$200,000,000)	$215,000,000	$204,000,000
Treatment Op. Cost (per MGal Treated)	$60	$66	$60
Present Value of 50-year Life-Cycle Cost	$782,604,000[2]	$572,321,000	$554,872,000
Notes	Costs for expanding DWU's overall treatment plant capacity by 102 mgd (by expanding the Elm Fork WTP if room for expansion is available) would be comparable to a new plant of the same size	Cost for conveyance is included in Project Conveyance Alternative costs	Cost for conveyance is included in Project Conveyance Alternative costs

Note (1): Distribution system costs (downstream of the WTP) are not included.

Note (2): The replacement of 102 mgd capacity at Elm Fork WTP is included in this figure. If this cost is excluded, the Present Value of the 50-year life-cycle cost is $335,572,000.

7.3 Capital Cost Analysis

7.3.1 Pipeline Unit Cost

Pipeline unit costs were developed for Steel Pipe and PCCP pipe. The opinion of probable cost estimate is based on the use of PCCP pipe in rural areas and assumes a cover depth of 4-feet (above top-of-pipe). The use of Steel Pipe is assumed in urban areas with a minimal cover depth of 5-feet to top-of-pipe.

PCCP and Steel Pipe prices are based on current material prices provided by local pipe manufacturers/suppliers. In **Tables 7-1 and 7-2** material unit prices were used to estimate pipeline construction cost.

Table 7-1
Pipeline Unit Costs - Steel Pipe

Internal Diameter	CL150 $/LF	CL200 $/LF
60"	$ 288	$ 307
72"	385	411
84"	497	535
96"	650	700
108"	819	924

Note: Unit prices for Steel pipe are supplier's prices and do not include general contractor's markup for O&P.
A 10% markup for overhead and profit was applied to material prices.

Table 7-2
Pipeline Unit Costs - PCCP Pipe

Internal Diameter	CL150 $/LF	CL200 $/LF
60"	$ 282	$ 310
72"	344	380
84"	457	511
96"	658	716
!08"	819	880

Note: Unit prices for PCCP pipe are supplier's prices and do not include general contractor's markup for O&P.
A 10% markup for overhead and profit was applied to material prices.

Pipe installation (pipe assembly, excavation, bedding and backfill) costs were developed using RS Means Cost Work; unit costs were indexed to Dallas/Fort Worth for 3rd Quarter 2008. It was assumed that the project would be constructed using non-union labor. Unit prices were developed based on an average production rate in rural areas ranging from 400 LF per day for 72-inch pipe to 250 LF per day for 108-inch pipe. Excavation and backfill costs were projected based on equipment and crew requirements. Backfill material in the pipe zone was assumed to be crushed rock (1 ft below bottom of pipe to 1 ft above top of pipe). Trench width in the pipe zone was assumed to be OD + 4 ft. Above the pipe zone, it was assumed that side slopes would be laid back at 2:1. Trench boxes are assumed to be used for trench protection in the pipe zone in urban areas.

The cost estimate assumes an "Urban" classification for all pipelines within City limits. Urban areas were identified from areal maps and GIS. Urban areas were divided into "Low Urban", "Medium Urban", and "Heavy Urban", where varying production rates were assumed for each classification. In undeveloped urban areas or

areas that are lightly populated (low density), a Low Urban rating was assigned. These areas have few visible surface constraints but may require relocation and/or protection of existing underground utilities since the work is within populated areas. A Medium Urban rating was assigned to portions of the alignment in areas having a moderate level of residential, commercial and industrial development. A Heavy Urban rating was assigned to densely developed areas that will require a large amount of surface restoration and likely involve a high degree of utility relocations.

It was assumed that the production rate for Low Urban was the same as Rural since the surface conditions are similar. The production rate for Medium Urban was assumed to 2/3 of Low Urban or Rural. Production in Heavy Urban areas was assumed to be half the rate as Low Urban. A factor was also applied to construction cost in urban areas to cover the cost of utility relocations. An additional 5% was applied to Medium Urban and 10% was applied to Heavy Urban.

Table 7-3
Pipeline Lengths within Rural and Urban Classifications

Pipe Segment	Rural (mi)	Low Urban (mi)	Medium Urban (mi)	Heavy Urban (mi)	Special Crossings / Tunnel	Total
3PL	75.1	30.7	10.7	1.7	10.5	128.7
SPL (Urban)	94.0	27.4	4.9	--	1.2	127.4
SPL (Rural)	118.7	7.6	1.9	--	1.1	129.3

Note: Lengths represent main transmission line, not interconnections (Richland-Chambers to Cedar Creek, Southern Pipeline to Joe Pool, Joe Pool to Bachman WTP)

Costs were developed for soft soil and hard soil conditions. It was assumed that pre-trenching would be required in areas having hard soil conditions. Pre-trenching would involve the use of large trenching equipment (wheel type trenchers) to rip through hard material (weathered shale, etc.). Typically a 3 foot wide pass would be made on each side of the trench and an excavator (hydraulic track-hoe) would be used to excavate out the center strip. Once the soil is ripped and removed from the trench it is then placed back in the trench until the time of pipe installation. This allows for easy excavation during pipe installation.

To cover appurtenances – isolation valves, air release and blow off valves, etc., a factor of 1.10 was applied to pipe construction costs. Costs for mobilization and other general requirements are also included in this factor.

7.3.2 Pump Station Costs

Pump Station pricing was developed from bid tabs of similar size projects with similar pump and piping configurations (comparable type, size and number of pumps). Costs for pumps, motors and drives were estimated based on current pricing provided by manufactures. Costs for pump suction and discharge piping (including headers and yard piping) and valves were estimated using bid tabs from past TRWD projects and inflated based on US Bureau of Reclamation and ENR escalation factors.

The following escalation rates were applied.

U.S. Bureau of Reclamation Construction Index for Pumping Stations	
Pumping Plants	5.20%
Structural Improvements	6.09%
Equipment – General	4.33%
Pumps	4.69%
Electrical (sub-stations)/ Misc. Equip	3.49%
Steel Pipe	4.90%

The use of horizontal split-case pumps was assumed at booster pump stations. It was also assumed that half the pumps at booster pump stations will be equipped with variable frequency drives (VFDs). Horizontal split-case pumps were assumed to be between 30,000 GPM to 40,000 GPM each (approximate pump suction and discharge size = 42" x 36"). Vertical turbine pumps (can-pumps) were assumed at lake-intake pump stations, each equipped with a VFD. Vertical turbine pump sizes were assumed to average 20,000 GPM each.

Costs for power supply to the pump stations were not explicitly calculated because of the lack of detailed information needed to calculate this variable.

7.3.3 Ground Storage Tanks

Ground storage was assumed to be 5% of total daily max flow. Estimated tank costs are based on the use of pre-stressed concrete wall tanks; tanks were assumed to be uncovered (open-top). Tanks were assumed to serve pump suction requirements and also provide storage for surge control. Tank prices were obtained from local manufactures.

7.3.4 Easements and Real Estate

Easements and property costs were assumed to be $15,000 per acre for rural and $70,000 per acre for urban areas. 140 ft permanent easements were assumed for all

pipelines. Pump station sites were assumed to be 10 acres and outlet facilities at lake discharge locations were assumed to be 5 acres.

7.4 Feasibility Level Opinions of Probable Cost Tables

Table 7-4
Southern "Rural" Pipeline

Segment	Diameter (inches)	Design Flow (mgd)	Length (mi)	Land Cost	Total Cost (2008 Dollar)	Original Phase 1 Estimate Cost	Original Phase 1 Length (mi)
Palestine to Cedar Creek	78	153	38.3	$10,000,000	$ 262,000,000	$1,120,000,000	135.4
Cedar Creek to Joe Pool Turnout	108	325	62.5	$16,000,000	$784,000,000		
Joe Pool Turnout to Benbrook	84	197	28.3	$9,000,000	$227,000,000		
Interconnection to Joe Pool Vicinity	72	128	7.4	$2,000,000	$38,000,000	$135,000,000	16.0
Richland-Chambers to Cedar Creek Interconnection	54	70	12.2	$3,000,000	$74,000,000	$93,000,000	15.2
Total	--	--	148.7	$41,000,000	$1,386,000,000	$1,355,000,000	171.1

Note: "Original Phase 1 Estimate Costs" were based on Region C unit cost parameterizations (land, pipe, etc.) and different assumptions on pipeline needs and lengths. See Phase 1 report for details.

Table 7-5
Southern "Urban" Pipeline

Segment	Diameter (inches)	Design Flow (mgd)	Length (mi)	Land Cost	Total Cost (2008 Dollar)	Original Phase 1 Estimate Cost	Original Phase 1 Length (mi)
Palestine to Cedar Creek	78	153	38.3	$10,000,000	$262,000,000	$1,120,000,000	135.4
Cedar Creek to Joe Pool Turnout	108	325	64.4	$18,000,000	$797,000,000		
Joe Pool Turnout to Benbrook	84	197	24.5	$10,000,000	$226,000,000		
Interconnection to Joe Pool Vicinity	72	128	1.6	$ -	$11,000,000	$135,000,000	16.0
Richland-Chambers to Cedar Creek Interconnection	54	70	12.2	$ 3,000,000	$74,000,000	$93,000,000	15.2
Total	--	--	141.0	$42,000,000	$1,371,000,000	$1,355,000,000	171.1

Note: "Original Phase 1 Estimate Costs" were based on Region C unit cost parameterizations (land, pipe, etc.) and different assumptions on pipeline needs and lengths. See Phase 1 report for details.

Table 7-6
Third Pipeline

Segment	Diameter (inches)	Design Flow (mgd)	Length (mi)	Land Cost	Total Cost (2008 Dollar)	Original Phase 1 Estimate Cost	Original Phase 1 Length (mi)
Palestine to Cedar Creek	78	153	38.3	$10,000,000	$262,000,000	$177,000,000	35.1
Cedar Creek to Ennis	96	255	32.3	$ 9,000,000	$327,000,000	$224,000,000	25.6
Ennis to Joe Pool Turnout	108	325	32.3	$15,000,000	$472,000,000	$562,000,000	48.3
Joe Pool Turnout to RHWTP	84	197	16.3	$ 9,000,000	$126,000,000		
RHWTP to Benbrook	84	197	9.2	$ 2,000,000	$187,000,000	N/A	0.0
RC to Ennis Alignment	54	70	29.7	$ 8,000,000	$141,000,000	$109,000,000	29.6
Total	--	--	158.2	$53,000,000	$1,515,000,000	$1,084,000,000	146.7

Note: "Original Phase 1 Estimate Costs" were based on Region C unit cost parameterizations (land, pipe, etc.) and different assumptions on pipeline needs and lengths. See Phase 1 report for details.

Table 7-7
Interconnection to Bachman WTP

Segment	Diameter (inches)	Design Flow (mgd)	Length (mi)	Land Cost	Total Cost (2008 Dollar)	Original Phase 1 Estimate Cost	Original Phase 1 Length (mi)
Joe Pool Lake Vicinity to Bachman WTP	78	128	27.8	$12,000,000	$211,000,000	$171,000,000	27.8

Note: "Original Phase 1 Estimate Costs" were based on Region C unit cost parameterizations (land, pipe, etc.) and different assumptions on pipeline needs and lengths. See Phase 1 report for details.

Table 7-8
Capital Cost Summary

Alternative	Total OPC (2008)	Total OPC (2015)
Southern Corridor - Rural Alignment	$1,386,000,000	1,597,000,000
Southern Corridor - Urban Alignment	$1,371,000,000	1,579,000,000
Third Pipeline	$1,515,000,000	1,744,000,000
Joe Pool to Bachman WTP	$211,000,000	242,000,000

Note: All costs are based on 3rd Quarter 2008 prices and then escalated to 2015 using an escalation rate of 3.46% per year.

7.5 Life Cycle Cost Analysis

This life cycle cost analysis is based on the same methodology used in the original Phase 1 analysis and documented previously (and therefore not repeated herein). Because the methodology is unchanged, the variables that require description are the energy consumption (cost factors are unchanged) and phasing potential (deferring capital cost expenditures). Energy consumption is addressed in Section 6 of this report and phasing is described in Section 5. Therefore, this section summarizes the results of the life cycle cost analyses and defers to the other sections of this report to describe methodologies or variables.

Table 7-9
Life Cycle Cost Analysis Results

Alternative	Present Worth of 50-year Life-Cycle Cost	Present Worth of 50-year Life-Cycle WITH PHASING
Southern Corridor - Rural Alignment	$ 2,435,000,000	$ 2,404,000,000
Southern Corridor - Urban Alignment	2,415,000,000	2,394,000,000
Third Pipeline	2,580,000,000	2,499,000,000
Joe Pool to Bachman WTP	263,000,000	N/A

As used in the original Phase 1 life cycle cost analyses, energy cost is $0.084/kwh and decreases at a 0.1% rate over time (based on the US Department of Energy Annual Energy Outlook 2008 Energy Prices by Sector and Source forecast).

Section 8
Comparison of Alternatives

8.1 Overview of Alternatives Comparison

One of the primary purposes of the ongoing Raw Water Transmission System Integration Study was to further refine the alternative pipeline corridors identified in the initial project viability assessment summary report dated July 2008. The integrated transmission configurations included in the initial project viability assessment can best be described as the Third Pipeline which would be generally located within the existing TRWD right of way, and a Southern Pipeline that would be located within a new corridor south of the 3rd pipeline alignment in more rural areas with adequate width to accommodate future water supply transmission facilities. The objective of the current analysis was to provide the City of Dallas and the Tarrant Regional Water District one project configuration that meets the needs of both parties.

The two basic raw water transmission configurations, the Third Pipeline and the Southern pipeline, described in detail in Section 2 of this report, were evaluated based on several quantitative and qualitative criteria identified during project workshop meetings and included:

- Capital Cost
- Operating Cost
- Supply Reliability
- Phasing Potential
- Water Sharing Potential
- Redundancy
- Future Planning Considerations

Table 8-1 provides a side by side comparison of these criteria for the Third Pipeline and Southern Pipeline corridors.

Table 8-1
Corridor Comparison Matrix

	3rd Pipeline	Southern Pipeline	Comments
Capital Cost	$1.52 Billion	$1.38 Billion	Significant cost saving potential with the Southern pipeline corridor
Average Annual Operating Cost	$47 Million/yr	$47 Million/yr	No appreciable difference
Supply Reliability	-	-	No appreciable difference
Construction Phasing Potential	Slightly greater		Timing of Lake Palestine connection to be addressed in MOU. Some western pipeline segments may be phased under either alternative
Water Sharing Potential	-	-	No appreciable difference
Redundancy	Pumps would operate from the same electrical source as existing TRWD facilities and have the same spatial vulnerabilities as existing pipelines	Alignment would isolate new flows from existing facilities, provide opportunities for separate electrical supplies, and isolate new pipeline from older existing pipeline	The Southern Pipeline provides power supply redundancy and isolation from existing pipeline facilities and would lessen the risk of catastrophic failure.
Future Planning	This corridor would utilize existing right-of-way to its fullest extent and includes the acquisition of additional easements in a separate corridor for future needs.	This option includes the acquisition of sufficient right-of-way such that after construction, each corridor will have space available for future needs.	The Southern Pipeline Corridor provides the best opportunity to reserve a water supply pipeline corridor for future East Texas supplies.

Third Pipeline

The TRWD has long planned to build a Third Pipeline within the existing 130' ROW that was purchased many years ago. One of the primary benefits of this alignment is that it represents the most direct route to the upper reach of Joe Pool Lake minimizing the pipeline length for raw water supplies for treatment and delivery into Dallas' western distribution system and to TRWD customer treatment plants. It also represents an existing ROW that could minimize scheduling delays associated with securing additional easements for a future integrated water transmission system.

Another benefit associated with this existing ROW is that existing TRWD facilities could be utilized (or expanded) to reduce the cost of connecting to terminal storage or water treatment plants. The existing pump stations at Ennis and Waxahachie were built with the planned Third Pipeline in mind and have VFD's and capacity to accommodate a new line. Also with the Third Pipeline in place, the system friction head would be lowered in the short term because water would be distributed between three large diameter pipelines instead of two, lowering power costs. Not only would the operating costs be reduced, it would delay the need to add pumping facilities until the system water demand increases to the point where the friction head requires that these additional facilities be added.

To accommodate planning for connection of future water supplies to the East of Lake Palestine, the purchase of additional ROW was considered in this analysis. Both integrated conveyance alternatives include the purchase of ROW sufficient for two pipelines. This reservation of a pipeline corridor for future use would ensure that additional urban growth in the North Texas area would not preclude or hinder the development of these East Texas supplies at a later date. Thus this ROW reservation would help maintain the viability of future water supplies from East Texas but would raise issues associated with the need to revise regional water plans and the advanced acquisition of property rights for a long range planned facility.

In terms of estimated capital, the Third Pipeline has an opinion of probable cost of $1.52 billion based upon 3rd quarter 2008 costing data while the Southern Pipeline opinion of probable cost is $1.38 billion, a difference of $140 million clearly favoring the Southern Pipeline concept.

No capital or operating cost allocation responsibility has been assigned to the two parties at this time to ensure that the comparison of approaches is unbiased. It is anticipated that both Dallas and TRWD will have full cost responsibility for certain facilities in either approach and that some additional facilities not included in the above opinions of probable cost may be necessary for one or both parties. Subsequent discussions between the parties will define cost, ownership, operations, and other terms that will be included in a joint agreement if a clear business case supports an integrated system.

Another important consideration in the comparison of the two alternative integrated system approaches is the potential to delay or phase certain aspects of the overall concepts and to therefore spread the associated capital costs over time. While there may also be opportunities to construct or expand pump stations and other ancillary facilities over time, our analysis was confined mainly to pipeline reaches, assuming that the opportunity for cost savings would be more substantial with respect to the pipelines. Both integrated system approaches were modeled to examine phasing strategies that would not reduce the firm supply reliability. Since it is estimated that Lake Palestine would not be needed on a firm basis until 2023, both the Third Pipeline and the Sothern Pipeline options could defer the connection of Lake Palestine to Cedar Creek Reservoir until that time.

he Third Pipeline option offers an additional opportunity to defer the connection between the Rolling Hills WTP and Lake Benbrook, perhaps as late as 2030, thereby spreading that estimated capital cost of more than $200 million over an additional 15 years. Generally the Third Pipeline offers greater flexibility in terms of overall phasing potential.

The Third Pipeline co-located parallel to TRWD's existing Cedar Creek and Richland-Chambers pipelines within a relatively narrow 130' wide corridor would represent a significant risk in terms of any catastrophic pipeline rupture, or power outages at critical pump stations along the way between the supply sources and points of delivery. These types of failures could potentially disrupt the entire water delivery to TRWD from eastern supplies for an extended period endangering most of Tarrant County's drinking water needs. The Dallas water system has more pathways for other backup supplies in the event of such a catastrophic failure in the Third Pipeline configuration and would not bear the same consequences of this risk.

An integrated water transmission system approach would provide water sharing potential between Dallas and TRWD to share its respective supply with the other when a surplus is available thus either deferring capital investments that would otherwise be needed in the absence of a joint system, or to manage operational costs by minimizing the use of supplies that are more distant when closer supplies are adequate. Both the Third Pipeline alternative and the Southern Pipeline alternative provide these potential benefits with no clear distinguishing differences.

Southern Pipeline

The Southern Pipeline configuration would provide a number of both short- and long-term benefits. The long-term benefits relate to the future use of East Texas water supplies. This project approach would ensure that adequate right of way would be acquired in the near term to reserve a corridor for future needs. Siting future water transmission facilities will become increasingly more difficult in the Dallas/Fort Worth area as existing rural land is quickly being converted to urban uses as the population of the metroplex is poised to double over the next 50 years. Rural land prices are an order-of-magnitude less expensive than urban land prices, construction in rural areas is faster and less expensive. Securing this ROW now will make future integration between the Dallas and TRWD systems much easier and will facilitate connecting new supplies from the east.

The Southern Pipeline route also provides compelling short-term redundancy and flexibility. If a failure were to occur in the existing TRWD eastern transmission facilities, the Southern Pipeline configuration would provide the flexibility to continue providing Tarrant County water deliveries while repairs were underway. Significantly, the Southern Pipeline approach offers the potential to diversify power supplies to vital pumping facilities.

In terms of joint system capital costs, the Southern Pipeline offers substantially lower initial investment cost, approximately $140 million, while providing similar average operating costs as the Third Pipeline.

8.2 Recommendation of Preferred Corridor

Based upon the analysis done to date, it is recommended that the general Southern Pipeline configuration be the basis of further engineering, institutional arrangement framework efforts, and project development studies and that the Southern Pipeline be the basis of subsequent considerations related to the efficacy of an integrated system approach versus separate individual water supply projects. The long term planning considerations coupled with the capital cost savings and operational redundancy for TRWD provides the most value for both agencies without sacrificing water supply reliability or construction phasing opportunities.

Section 9
Project Delivery Plan and Schedule

9.1 Tasks

The primary purpose of developing the project delivery plan and schedule was to outline the tasks necessary to provide Dallas and TRWD a more thorough understanding of the technical, financial, and institutional issues associated with advancing an integrated raw water transmission system toward implementation, should an adequate business case exist for each party.

The project delivery plan and schedule is a dynamic document intended to be updated as the project progresses and is tailored to project goals. It is therefore constructed around the City of Dallas and TRWD primary goals **to ensure 100% water supply reliability for their respective customers** by delivering additional unconnected water supplies. Significant work elements continue to be developed to support the June 2009 decision-point goal to provide both governing and advisory bodies with sufficient information to understand the ramifications of a joint undertaking. This project delivery plan focuses on identification of the complex institutional, contractual, funding, permitting, and engineering and construction issues of proposed integrated raw water transmission facilities.

While important evaluations continue regarding all aspects of the integrated water transmission project, this preliminary project plan and schedule assumes the following:

- Project development work unrelated to the Go/No Go decision will be limited prior to July 2009, focusing only on those tasks on the project's critical path or issues related to independent facilities that would, absent consensus on joint facilities, be pursued by each system concurrently.

- Conceptual Design and the development of a design documentation report would commence after a contractual decision by project partners, currently projected for early 2010.

- The design documentation effort would focus on documenting design decisions to support detailed design, and provide consistency in the specification of materials and design approaches. This preliminary design approach will permit more flexibility in terms of project delivery methods that might ultimately be used for detailed design and construction.

- Design decisions related to the TRWD Cedar Creek constructed wetland project (by others) will be closely coordinated with the conceptual design and permitting of the Cedar Creek Reservoir water intake design and construction.

- The design and construction timeline outlined in the preliminary project schedule is predicated upon a traditional project delivery approach, design/bid/build.

Consideration of project phasing, project packaging, and alternate project delivery will be more fully developed as the institutional issues and project funding are considered. In addition, subsequent project plan updates will consider the available delivery capacity of the engineering and construction sectors and the large diameter pipe and other critical materials manufacturing capacity.

9.2 Schedule

The project plan schedule has been developed in Microsoft Project and is attached. The primary project delivery tasks and their generalized timeframes are:

- Ongoing Development and Approval of Institutional & Financial Framework (1/2009 – 1/2010)
- Ongoing project development studies (1/2009 – 1/2010)
- Route Study and Pump Station Site Alternatives (2/2009 – 1/2010)
- Environmental Analysis and Permitting (6/2009 – 6/2012)
- Real Estate Acquisition (Start planning January 2010, finish by January 2014)
- Preliminary design and design documentation report (Start February 2010, 12 month duration)
- Detailed Design (Start January 2011, 24 month duration)
- Construction (Start June 2013, 3.5 year duration; dependent on construction sequencing and phasing opportunities)

PROJECT BUDGET - Entity Name - Tarrant Regional Water District (City of Dallas)						
Uses	**TWDB Funds Series 1**	**TWDB Funds Series 2**	**TWDB Funds Series 3**	**Total TWDB Cost**	**Other Funds**	**Total Cost**
Construction						
Construction	$94,490,000	$0	$0	$94,490,000	$13,030,000	$107,520,000
Subtotal Construction	**$94,490,000**	**$0**	**$0**	**$94,490,000**	**$13,030,000**	**$107,520,000**
Basic Engineering Fees						
Planning +	$0	$0	$0	$0	$0	$0
Design	$720,000	$0	$0	$720,000	$8,100,000	$8,820,000
Construction Engineering	$1,680,000	$0	$0	$1,680,000	$6,750,000	$8,430,000
Basic Engineering Other **_____	$0	$0	$0	$0	$0	$0
Subtotal Basic Engineering Fees	**$2,400,000**	**$0**	**$0**	**$2,400,000**	**$14,850,000**	**$17,250,000**
Special Services						
Application	$0	$0	$0	$0	$0	$0
Environmental	$0	$0	$0	$0	$0	$0
Water Conservation Plan	$0	$0	$0	$0	$0	$0
I/I Studies/Sewer Evaluation	$0	$0	$0	$0	$0	$0
Surveying	$1,310,000	$0	$0	$1,310,000	$0	$1,310,000
Geotechnical	$0	$0	$0	$0	$0	$0
Testing	$740,000	$0	$0	$740,000	$590,000	$1,330,000
Permits	$0	$0	$0	$0	$0	$0
Inspection	$0	$0	$0	$0	$0	$0
O&M Manual	$0	$0	$0	$0	$0	$0
Project Management (by engineer)	$7,940,000	$0	$0	$7,940,000	$2,240,000	$10,180,000
Pilot Testing	$0	$0	$0	$0	$0	$0
Water Distribution Modeling	$0	$0	$0	$0	$0	$0
Special Services Other **_____	$0	$0	$0	$0	$0	$0
Subtotal Special Services	**$9,990,000**	**$0**	**$0**	**$9,990,000**	**$2,830,000**	**$12,820,000**
Other						
Administration	$10,850,000	$0	$0	$10,850,000	$12,110,000	$22,960,000
Land/Easements Acquisition	$12,770,000	$0	$0	$12,770,000	$12,030,000	$24,800,000
Water Rights Purchase (If Applicable)	$0	$0	$0	$0	$0	$0
Capacity Buy-In (If Applicable)	$0	$0	$0	$0	$0	$0
Project Legal Expenses	$0	$0	$0	$0	$0	$0
Other **	$0	$0	$0	$0	$0	$0
Subtotal Other Services	**$23,620,000**	**$0**	**$0**	**$23,620,000**	**$24,140,000**	**$47,760,000**
Fiscal Services						
Financial Advisor	$0	$0	$0	$0	$0	$0
Bond Counsel	$0	$0	$0	$0	$0	$0
Issuance Cost	$420,000	$0	$0	$420,000	$310,000	$730,000
Bond Insurance/Surety	$0	$0	$0	$0	$0	$0
Fiscal/Legal	$0	$0	$0	$0	$0	$0
Capitalized Interest	$0	$0	$0	$0	$0	$0
Bond Reserve Fund	$8,170,000	$0	$0	$8,170,000	$6,970,000	$15,140,000
Loan Origination Fee	$0	$0	$0	$0	$0	$0
Other **	$0	$0	$0	$0	$0	$0
Subtotal Fiscal Services	**$8,590,000**	**$0**	**$0**	**$8,590,000**	**$7,280,000**	**$15,870,000**
Contingency						
Contingency	$910,000	$0	$0	$910,000	$4,870,000	$5,780,000
Subtotal Contingency	**$910,000**	**$0**	**$0**	**$910,000**	**$4,870,000**	**$5,780,000**
TOTAL COSTS	**$140,000,000**	**$0**	**$0**	**$140,000,000**	**$67,000,000**	**$207,000,000**

Other ** description must be entered

+ For Planning applications under the EDAP Program, please break down Planning costs as follows:

Category A			0
Category B			0
Category C			0
Category D			0
Total Planning Costs	0	0	0

PROJECT BUDGET - Entity Name - Tarrant Regional Water District - TRWD Bond						
Uses	**TWDB Funds Series 1**	**TWDB Funds Series 2**	**TWDB Funds Series 3**	**Total TWDB Cost**	**Other Funds**	**Total Cost**
Construction						
Construction	$217,630,000	$0	$0	$217,630,000	$123,270,000	$340,900,000
Subtotal Construction	**$217,630,000**	**$0**	**$0**	**$217,630,000**	**$123,270,000**	**$340,900,000**
Basic Engineering Fees						
Planning +	$0	$0	$0	$0	$0	$0
Design	$1,250,000	$0	$0	$1,250,000	$0	$1,250,000
Construction Engineering	$4,540,000	$0	$0	$4,540,000	$3,970,000	$8,510,000
Basic Engineering Other ** _____	$0	$0	$0	$0	$0	$0
Subtotal Basic Engineering Fees	**$5,790,000**	**$0**	**$0**	**$5,790,000**	**$3,970,000**	**$9,760,000**
Special Services						
Application	$0	$0	$0	$0	$0	$0
Environmental	$0	$0	$0	$0	$0	$0
Water Conservation Plan	$0	$0	$0	$0	$0	$0
I/I Studies/Sewer Evaluation	$0	$0	$0	$0	$0	$0
Surveying	$1,430,000	$0	$0	$1,430,000	$0	$1,430,000
Geotechnical	$0	$0	$0	$0	$0	$0
Testing	$2,090,000	$0	$0	$2,090,000	$1,800,000	$3,890,000
Permits	$0	$0	$0	$0	$0	$0
Inspection	$0	$0	$0	$0	$0	$0
O&M Manual	$0	$0	$0	$0	$0	$0
Project Management (by engineer)	$14,910,000	$0	$0	$14,910,000	$6,700,000	$21,610,000
Pilot Testing	$0	$0	$0	$0	$0	$0
Water Distribution Modeling	$0	$0	$0	$0	$0	$0
Special Services Other ** _____	$0	$0	$0	$0	$0	$0
Subtotal Special Services	**$18,430,000**	**$0**	**$0**	**$18,430,000**	**$8,500,000**	**$26,930,000**
Other						
Administration	$15,960,000	$0	$0	$15,960,000	$16,300,000	$32,260,000
Land/Easements Acquisition	$24,660,000	$0	$0	$24,660,000	$17,970,000	$42,630,000
Water Rights Purchase (If Applicable)	$0	$0	$0	$0	$0	$0
Capacity Buy-In (If Applicable)	$0	$0	$0	$0	$0	$0
Project Legal Expenses	$0	$0	$0	$0	$0	$0
Other **	$0	$0	$0	$0	$0	$0
Subtotal Other Services	**$40,620,000**	**$0**	**$0**	**$40,620,000**	**$34,270,000**	**$74,890,000**
Fiscal Services						
Financial Advisor	$0	$0	$0	$0	$0	$0
Bond Counsel	$0	$0	$0	$0	$0	$0
Issuance Cost	$790,000	$0	$0	$790,000	$650,000	$1,440,000
Bond Insurance/Surety	$0	$0	$0	$0	$0	$0
Fiscal/Legal	$0	$0	$0	$0	$0	$0
Capitalized Interest	$0	$0	$0	$0	$0	$0
Bond Reserve Fund	$15,120,000	$0	$0	$15,120,000	$14,380,000	$29,500,000
Loan Origination Fee	$0	$0	$0	$0	$0	$0
Other **	$0	$0	$0	$0	$0	$0
Subtotal Fiscal Services	**$15,910,000**	**$0**	**$0**	**$15,910,000**	**$15,030,000**	**$30,940,000**
Contingency						
Contingency	$1,620,000	$0	$0	$1,620,000	$9,660,000	$11,280,000
Subtotal Contingency	**$1,620,000**	**$0**	**$0**	**$1,620,000**	**$9,660,000**	**$11,280,000**
TOTAL COSTS	**$300,000,000**	**$0**	**$0**	**$300,000,000**	**$194,700,000**	**$494,700,000**

Other ** description must be entered

+ For Planning applications under the EDAP Program, please break down Planning costs as follows:

Category A			0
Category B			0
Category C			0
Category D			0
Total Planning Costs	0	0	0

TWDB-1202
Revised 2/22/2011

PROJECTED DRAW SCHEDULE FOR

Template must be downloaded and saved prior to printing.

Entity Name: Tarrant Regional Water District - DWL

Project No.:

Please complete all areas shaded in blue.

Gray shaded areas will compute automatically.

Date Prepared: May 1 2015

By my signature, I acknowledge I have reviewed the project draw schedule incorporated herein and to the best of my knowledge it is an accurate reflection of the anticipated project financial needs at this time.

	Print Name	Signature	Date
Owner:	Sandra Newby		
Engineer:	Ed Weaver		
Financial Advisor:	Laura Alexander		

Financial Advisor signature needed prior to closing only.

Entires must include all Fiscal Costs associated with the project except contingency.
Show the contingency in the month immediately after completion of the project.
Entires must match budgeted amounts.

Source of Funds		DWSRF	EDAP	SWIFT	Total		Cummulative	Debt Service
Loan/Grant #					Project Costs	Total Draws	Draws	Maturities
Loan/Grant Amount			$ -	$ 140,000,000	$140,000,000			
Actual or Estimated Closing Date	Nov-15							
	Dec-15			$ 8,590,000		$ 8,590,000	$ 8,590,000	
	Jan-16	$ -		$ 74,790,000		$ 74,790,000	$ 83,380,000	
	Feb-16			$ -		$ -	$ 83,380,000	
	Mar-16			$ 2,840,000		$ 2,840,000	$ 86,220,000	
	Apr-16			$ 7,940,000		$ 7,940,000	$ 94,160,000	
	May-16			$ 20,000,000		$ 20,000,000	$ 114,160,000	
	Jun-16			$ 4,300,000		$ 4,300,000	$ 118,460,000	
	Jul-16					$ -	$ 118,460,000	
	Aug-16					$ -	$ 118,460,000	
	Sep-16					$ -	$ 118,460,000	
	Oct-16					$ -	$ 118,460,000	
	Nov-16					$ -	$ 118,460,000	

Dec-16		$ -	$ -	$ 118,460,000	
Jan-17		$ 4,300,000	$ 4,300,000	$ 122,760,000	
Feb-17	$ -		$ -	$ 122,760,000	
Mar-17	$ -		$ -	$ 122,760,000	
Apr-17	$ -		$ -	$ 122,760,000	
May-17	$ -		$ -	$ 122,760,000	
Jun-17	$ -	$ 4,300,000	$ 4,300,000	$ 127,060,000	
Jul-17	$ -		$ -	$ 127,060,000	
Aug-17	$ -		$ -	$ 127,060,000	
Sep-17	$ -		$ -	$ 127,060,000	
Oct-17			$ -	$ 127,060,000	
Nov-17			$ -	$ 127,060,000	
Dec-17		$ 4,300,000	$ 4,300,000	$ 131,360,000	
Jan-18			$ -	$ 131,360,000	
Feb-18			$ -	$ 131,360,000	
Mar-18			$ -	$ 131,360,000	
Apr-18			$ -	$ 131,360,000	
May-18			$ -	$ 131,360,000	
Jun-18		$ 4,300,000	$ 4,300,000	$ 135,660,000	
Jul-18			$ -	$ 135,660,000	
Aug-18			$ -	$ 135,660,000	
Sep-18			$ -	$ 135,660,000	
Oct-18			$ -	$ 135,660,000	
Nov-18			$ -	$ 135,660,000	
Dec-18		$ 4,340,000	$ 4,340,000	$ 140,000,000	
Jan-19			$ -	$ 140,000,000	
Feb-19			$ -	$ 140,000,000	
Mar-19			$ -	$ 140,000,000	
Apr-19			$ -	$ 140,000,000	
May-19			$ -	$ 140,000,000	
Jun-19			$ -	$ 140,000,000	
Jul-19			$ -	$ 140,000,000	
Aug-19			$ -	$ 140,000,000	
Sep-19			$ -	$ 140,000,000	
Oct-19			$ -	$ 140,000,000	
Nov-19			$ -	$ 140,000,000	
Dec-19			$ -	$ 140,000,000	
Jan-20			$ -	$ 140,000,000	
Feb-20			$ -	$ 140,000,000	

Mar-20				$ -	$ 140,000,000
Apr-20				$ -	$ 140,000,000
May-20				$ -	$ 140,000,000
Jun-20				$ -	$ 140,000,000
Jul-20				$ -	$ 140,000,000
Aug-20				$ -	$ 140,000,000
Sep-20				$ -	$ 140,000,000
Oct-20				$ -	$ 140,000,000
Nov-20				$ -	$ 140,000,000
Dec-20				$ -	$ 140,000,000
Jan-21				$ -	$ 140,000,000
Feb-21				$ -	$ 140,000,000
Mar-21				$ -	$ 140,000,000
Apr-21				$ -	$ 140,000,000
May-21				$ -	$ 140,000,000
Jun-21				$ -	$ 140,000,000
Jul-21				$ -	$ 140,000,000
Aug-21				$ -	$ 140,000,000
Sep-21				$ -	$ 140,000,000
Oct-21				$ -	$ 140,000,000
Nov-21				$ -	$ 140,000,000
Dec-21				$ -	$ 140,000,000
Jan-22				$ -	$ 140,000,000

TWDB-1202
Revised 2/22/2011

PROJECTED DRAW SCHEDULE FOR

Template must be downloaded and saved prior to printing.

Entity Name: **Tarrant Regional Water District**

Project No.:

Please complete all areas shaded in blue.

Gray shaded areas will compute automatically.

Date Prepared: May 1 2015

By my signature, I acknowledge I have reviewed the project draw schedule incorporated herein and to the best of my knowledge it is an accurate reflection of the anticipated project financial needs at this time.

	Print Name	Signature	Date
Owner:	Sandra Newby		
Engineer:	Ed Weaver		
Financial Advisor:	Laura Alexander		

Financial Advisor signature needed prior to closing only.

Entires must include all Fiscal Costs associated with the project except contingency.
Show the contingency in the month immediately after completion of the project.
Entires must match budgeted amounts.

Source of Funds		DWSRF	EDAP	SWIFT	Total			
Loan/Grant #					Project Costs	Total Draws	Cummulative Draws	Debt Service Maturities
Loan/Grant Amount			$ -	$ 300,000,000	$300,000,000			
Actual or Estimated Closing Date	Nov-15							
	Dec-15			$ 15,910,000		$ 15,910,000	$ 15,910,000	
	Jan-16	$ -		$ 1,250,000		$ 1,250,000	$ 17,160,000	
	Feb-16			$ -		$ -	$ 17,160,000	
	Mar-16			$ 202,700,000		$ 202,700,000	$ 219,860,000	
	Apr-16			$ 14,910,000		$ 14,910,000	$ 234,770,000	
	May-16					$ -	$ 234,770,000	
	Jun-16			$ 7,300,000		$ 7,300,000	$ 242,070,000	
	Jul-16					$ -	$ 242,070,000	
	Aug-16					$ -	$ 242,070,000	
	Sep-16					$ -	$ 242,070,000	
	Oct-16					$ -	$ 242,070,000	
	Nov-16					$ -	$ 242,070,000	

Dec-16				$	21,560,000	$	21,560,000	$	263,630,000
Jan-17				$	7,300,000	$	7,300,000	$	270,930,000
Feb-17		$	-			$	-	$	270,930,000
Mar-17		$	-			$	-	$	270,930,000
Apr-17		$	-			$	-	$	270,930,000
May-17		$	-			$	-	$	270,930,000
Jun-17		$	-	$	7,300,000	$	7,300,000	$	278,230,000
Jul-17		$	-			$	-	$	278,230,000
Aug-17		$	-			$	-	$	278,230,000
Sep-17						$	-	$	278,230,000
Oct-17						$	-	$	278,230,000
Nov-17						$	-	$	278,230,000
Dec-17				$	7,300,000	$	7,300,000	$	285,530,000
Jan-18						$	-	$	285,530,000
Feb-18						$	-	$	285,530,000
Mar-18						$	-	$	285,530,000
Apr-18						$	-	$	285,530,000
May-18						$	-	$	285,530,000
Jun-18				$	7,300,000	$	7,300,000	$	292,830,000
Jul-18						$	-	$	292,830,000
Aug-18						$	-	$	292,830,000
Sep-18						$	-	$	292,830,000
Oct-18						$	-	$	292,830,000
Nov-18						$	-	$	292,830,000
Dec-18				$	7,170,000	$	7,170,000	$	300,000,000
Jan-19						$	-	$	300,000,000
Feb-19						$	-	$	300,000,000
Mar-19						$	-	$	300,000,000
Apr-19						$	-	$	300,000,000
May-19						$	-	$	300,000,000
Jun-19						$	-	$	300,000,000
Jul-19						$	-	$	300,000,000
Aug-19						$	-	$	300,000,000
Sep-19						$	-	$	300,000,000
Oct-19						$	-	$	300,000,000
Nov-19						$	-	$	300,000,000
Dec-19						$	-	$	300,000,000
Jan-20						$	-	$	300,000,000
Feb-20						$	-	$	300,000,000

Mar-20				$ -	$ 300,000,000
Apr-20				$ -	$ 300,000,000
May-20				$ -	$ 300,000,000
Jun-20				$ -	$ 300,000,000
Jul-20				$ -	$ 300,000,000
Aug-20				$ -	$ 300,000,000
Sep-20				$ -	$ 300,000,000
Oct-20				$ -	$ 300,000,000
Nov-20				$ -	$ 300,000,000
Dec-20				$ -	$ 300,000,000
Jan-21				$ -	$ 300,000,000
Feb-21				$ -	$ 300,000,000
Mar-21				$ -	$ 300,000,000
Apr-21				$ -	$ 300,000,000
May-21				$ -	$ 300,000,000
Jun-21				$ -	$ 300,000,000
Jul-21				$ -	$ 300,000,000
Aug-21				$ -	$ 300,000,000
Sep-21				$ -	$ 300,000,000
Oct-21				$ -	$ 300,000,000
Nov-21				$ -	$ 300,000,000
Dec-21				$ -	$ 300,000,000
Jan-22				$ -	$ 300,000,000

Integrated Pipeline Program
Current Construction Schedule
TWDB

PL 10/PL 11
Start: 3/1/2016
End: 2/28/2018

DWU
Start: 1/1/2016
End: 6/1/2017

PL 9
Start: 1/3/2033
End: 7/5/2035

PL 12/PL 13/MBR
Start: 11/10/2014
End: 4/7/2017

JB4
Start: 7/1/2031
End: 7/3/2035

JB4 Bypass
Start: 3/1/2016
End: 2/28/2018

Existing TRWD Pipelines

JB3
Start: 7/21/2014
End: 2/13/2018

PL 14
Start: 1/1/2016
End: 10/31/2017

PL 17/PL 18
Start: 3/1/2016
End: 11/30/2020

JCC1 Intake
Start: 12/1/2016
End: 5/31/2019

JCC1 PS
Start: 11/29/2018
End: 6/01/2021

PL 19-1
Start: 7/1/2020
End: 12/28/2022

PL 15-2
Start: 7/16/2015
End: 7/19/2017

PL 15-1
Start: 5/1/2014
End: 8/6/2015

JB2
Start: 7/1/2026
End: 7/3/2030

PL 19-2
Start: 1/2/2022
End: 7/3/2024

PL 16
Start: 9/1/2028
End: 3/10/2031

JRC1
Start: 7/1/2028
End: 7/3/2032

LP1 Intake
Start: 7/1/2020
End: 12/29/2022

LP1 PS
Start: 7/3/2022
End: 12/31/2024

Includes Land Cost for IPL Section 9, 16, 19-2 and 19-1

Census Tracts Contained within the DWU Service Area

ID	County ID	Census Tract Name
1	113	Census Tract 166.12
2	113	Census Tract 122.11
3	113	Census Tract 124
4	113	Census Tract 165.13
5	113	Census Tract 165.14
6	113	Census Tract 165.17
7	113	Census Tract 165.18
8	113	Census Tract 165.19
9	113	Census Tract 166.05
10	113	Census Tract 166.06
11	113	Census Tract 166.07
12	113	Census Tract 166.10
13	113	Census Tract 166.11
14	113	Census Tract 136.09
15	113	Census Tract 136.10
16	113	Census Tract 136.11
17	113	Census Tract 153.06
18	113	Census Tract 154.01
19	113	Census Tract 154.03
20	113	Census Tract 154.04
21	113	Census Tract 155
22	113	Census Tract 156
23	113	Census Tract 79.14
24	113	Census Tract 136.25
25	113	Census Tract 176.05
26	113	Census Tract 116.02
27	113	Census Tract 117.01
28	113	Census Tract 117.02
29	113	Census Tract 120
30	113	Census Tract 121
31	113	Census Tract 122.04
32	113	Census Tract 122.06
33	113	Census Tract 122.07
34	113	Census Tract 118
35	113	Census Tract 122.08
36	113	Census Tract 107.03
37	113	Census Tract 107.04
38	113	Census Tract 9801
39	113	Census Tract 6.05
40	113	Census Tract 164.07
41	113	Census Tract 71.01
42	113	Census Tract 168.04
43	113	Census Tract 91.05
44	113	Census Tract 122.10

Census Tracts Contained within the DWU Service Area

ID	County ID	Census Tract Name
45	113	Census Tract 96.10
46	113	Census Tract 141.21
47	113	Census Tract 137.13
48	113	Census Tract 42.01
49	113	Census Tract 170.01
50	113	Census Tract 171.02
51	113	Census Tract 111.05
52	113	Census Tract 59.01
53	113	Census Tract 60.01
54	113	Census Tract 60.02
55	113	Census Tract 62
56	113	Census Tract 63.01
57	113	Census Tract 63.02
58	113	Census Tract 65.01
59	113	Census Tract 65.02
60	113	Census Tract 108.01
61	113	Census Tract 112
62	113	Census Tract 113
63	113	Census Tract 18
64	113	Census Tract 19
65	113	Census Tract 20
66	113	Census Tract 21
67	113	Census Tract 12.02
68	113	Census Tract 12.03
69	113	Census Tract 158
70	113	Census Tract 119
71	113	Census Tract 169.03
72	113	Census Tract 166.17
73	113	Census Tract 87.03
74	113	Census Tract 140.02
75	113	Census Tract 141.24
76	113	Census Tract 77
77	113	Census Tract 137.11
78	113	Census Tract 141.14
79	113	Census Tract 153.04
80	113	Census Tract 147.03
81	113	Census Tract 164.06
82	113	Census Tract 115
83	113	Census Tract 59.02
84	113	Census Tract 76.01
85	113	Census Tract 76.04
86	113	Census Tract 76.05
87	113	Census Tract 78.01
88	113	Census Tract 78.04

Census Tracts Contained within the DWU Service Area

ID	County ID	Census Tract Name
89	113	Census Tract 78.05
90	113	Census Tract 78.11
91	113	Census Tract 47
92	113	Census Tract 48
93	113	Census Tract 49
94	113	Census Tract 50
95	113	Census Tract 51
96	113	Census Tract 52
97	113	Census Tract 25
98	113	Census Tract 27.02
99	113	Census Tract 190.19
100	257	Census Tract 502.06
101	113	Census Tract 54
102	113	Census Tract 55
103	113	Census Tract 53
104	113	Census Tract 56
105	113	Census Tract 136.24
106	113	Census Tract 57
107	113	Census Tract 78.15
108	113	Census Tract 78.18
109	113	Census Tract 78.19
110	113	Census Tract 79.02
111	113	Census Tract 22
112	113	Census Tract 24
113	113	Census Tract 27.01
114	121	Census Tract 217.28
115	113	Census Tract 80
116	113	Census Tract 81
117	113	Census Tract 82
118	113	Census Tract 114.01
119	121	Census Tract 215.23
120	121	Census Tract 216.11
121	121	Census Tract 216.12
122	121	Census Tract 216.13
123	121	Census Tract 216.14
124	121	Census Tract 216.16
125	121	Census Tract 206.01
126	113	Census Tract 88.02
127	113	Census Tract 89
128	121	Census Tract 216.27
129	113	Census Tract 96.03
130	113	Census Tract 96.04
131	113	Census Tract 96.05
132	113	Census Tract 96.07

Census Tracts Contained within the DWU Service Area

ID	County ID	Census Tract Name
133	113	Census Tract 96.08
134	113	Census Tract 96.09
135	113	Census Tract 96.11
136	113	Census Tract 97.02
137	113	Census Tract 92.02
138	113	Census Tract 93.01
139	113	Census Tract 93.04
140	121	Census Tract 208
141	121	Census Tract 204.01
142	121	Census Tract 202.02
143	121	Census Tract 203.03
144	121	Census Tract 214.03
145	121	Census Tract 216.15
146	121	Census Tract 203.05
147	121	Census Tract 204.02
148	121	Census Tract 204.03
149	121	Census Tract 206.02
150	121	Census Tract 207
151	121	Census Tract 209
152	121	Census Tract 210
153	121	Census Tract 211
154	121	Census Tract 213.01
155	121	Census Tract 215.02
156	121	Census Tract 215.05
157	121	Census Tract 214.09
158	113	Census Tract 84
159	113	Census Tract 85
160	113	Census Tract 86.04
161	113	Census Tract 87.01
162	113	Census Tract 87.04
163	113	Census Tract 88.01
164	113	Census Tract 98.02
165	113	Census Tract 91.04
166	439	Census Tract 1115.13
167	139	Census Tract 605
168	139	Census Tract 606
169	139	Census Tract 613
170	139	Census Tract 602.07
171	139	Census Tract 609
172	139	Census Tract 602.04
173	139	Census Tract 603
174	139	Census Tract 601.01
175	139	Census Tract 604
176	139	Census Tract 611

Census Tracts Contained within the DWU Service Area

ID	County ID	Census Tract Name
177	139	Census Tract 602.06
178	439	Census Tract 1139.06
179	439	Census Tract 1139.10
180	139	Census Tract 602.13
181	139	Census Tract 602.11
182	139	Census Tract 607.02
183	139	Census Tract 602.14
184	139	Census Tract 607.03
185	139	Census Tract 608.03
186	139	Census Tract 607.01
187	139	Census Tract 602.08
188	139	Census Tract 602.12
189	139	Census Tract 602.10
190	139	Census Tract 602.09
191	497	Census Tract 1501.01
192	497	Census Tract 1506.03
193	085	Census Tract 317.04
194	121	Census Tract 203.06
195	113	Census Tract 185.03
196	085	Census Tract 316.49
197	439	Census Tract 1115.38
198	113	Census Tract 190.16
199	439	Census Tract 1137.03
200	113	Census Tract 190.34
201	113	Census Tract 190.35
202	113	Census Tract 170.03
203	113	Census Tract 170.04
204	113	Census Tract 171.01
205	113	Census Tract 172.01
206	113	Census Tract 172.02
207	113	Census Tract 192.05
208	113	Census Tract 192.08
209	113	Census Tract 173.01
210	113	Census Tract 173.06
211	113	Census Tract 193.01
212	113	Census Tract 195.01
213	113	Census Tract 195.02
214	113	Census Tract 196
215	113	Census Tract 197
216	113	Census Tract 198
217	113	Census Tract 199
218	113	Census Tract 136.07
219	113	Census Tract 159
220	113	Census Tract 126.04

Census Tracts Contained within the DWU Service Area

ID	County ID	Census Tract Name
221	113	Census Tract 130.10
222	113	Census Tract 136.22
223	113	Census Tract 136.21
224	113	Census Tract 136.23
225	113	Census Tract 141.35
226	113	Census Tract 141.34
227	113	Census Tract 141.33
228	113	Census Tract 141.36
229	113	Census Tract 141.29
230	113	Census Tract 143.11
231	113	Census Tract 165.23
232	113	Census Tract 166.25
233	113	Census Tract 166.26
234	113	Census Tract 166.21
235	113	Census Tract 166.23
236	113	Census Tract 192.13
237	113	Census Tract 137.26
238	113	Census Tract 166.24
239	113	Census Tract 166.22
240	113	Census Tract 79.11
241	113	Census Tract 109.03
242	113	Census Tract 17.03
243	113	Census Tract 192.12
244	113	Census Tract 203
245	113	Census Tract 205
246	113	Census Tract 206
247	113	Census Tract 207
248	113	Census Tract 141.27
249	113	Census Tract 123.01
250	113	Census Tract 123.02
251	085	Census Tract 317.13
252	085	Census Tract 303.05
253	085	Census Tract 317.11
254	439	Census Tract 1137.05
255	085	Census Tract 317.12
256	085	Census Tract 317.14
257	085	Census Tract 317.16
258	085	Census Tract 317.15
259	085	Census Tract 317.20
260	085	Census Tract 317.19
261	113	Census Tract 17.04
262	113	Census Tract 136.26
263	113	Census Tract 108.03
264	113	Census Tract 109.02

Census Tracts Contained within the DWU Service Area

ID	County ID	Census Tract Name
265	439	Census Tract 1130.02
266	113	Census Tract 110.02
267	113	Census Tract 111.01
268	113	Census Tract 111.03
269	113	Census Tract 111.04
270	113	Census Tract 101.01
271	113	Census Tract 101.02
272	113	Census Tract 105
273	113	Census Tract 106.01
274	113	Census Tract 106.02
275	113	Census Tract 201
276	113	Census Tract 202
277	113	Census Tract 141.28
278	113	Census Tract 165.22
279	113	Census Tract 6.06
280	121	Census Tract 202.04
281	121	Census Tract 202.05
282	121	Census Tract 201.15
283	121	Census Tract 214.05
284	121	Census Tract 215.15
285	121	Census Tract 215.27
286	121	Census Tract 201.14
287	121	Census Tract 205.06
288	121	Census Tract 205.04
289	121	Census Tract 203.08
290	121	Census Tract 213.04
291	121	Census Tract 217.18
292	121	Census Tract 215.13
293	121	Census Tract 216.19
294	121	Census Tract 217.20
295	121	Census Tract 216.23
296	121	Census Tract 216.25
297	121	Census Tract 216.22
298	113	Census Tract 168.03
299	113	Census Tract 78.12
300	113	Census Tract 98.03
301	113	Census Tract 137.17
302	113	Census Tract 61
303	113	Census Tract 31.01
304	121	Census Tract 216.36
305	113	Census Tract 34
306	113	Census Tract 78.09
307	113	Census Tract 136.18
308	113	Census Tract 99

Census Tracts Contained within the DWU Service Area

ID	County ID	Census Tract Name
309	113	Census Tract 98.04
310	113	Census Tract 165.16
311	113	Census Tract 92.01
312	113	Census Tract 91.03
313	113	Census Tract 100
314	113	Census Tract 15.04
315	113	Census Tract 143.08
316	113	Census Tract 67
317	113	Census Tract 68
318	113	Census Tract 69
319	113	Census Tract 97.01
320	113	Census Tract 137.12
321	113	Census Tract 146.03
322	113	Census Tract 166.18
323	113	Census Tract 166.19
324	113	Census Tract 167.03
325	113	Census Tract 1
326	113	Census Tract 2.01
327	113	Census Tract 2.02
328	113	Census Tract 3
329	113	Census Tract 4.01
330	113	Census Tract 4.04
331	113	Census Tract 5
332	113	Census Tract 6.01
333	113	Census Tract 6.03
334	113	Census Tract 7.01
335	113	Census Tract 7.02
336	113	Census Tract 8
337	113	Census Tract 9
338	113	Census Tract 4.05
339	113	Census Tract 10.01
340	113	Census Tract 10.02
341	113	Census Tract 11.02
342	113	Census Tract 12.04
343	113	Census Tract 13.01
344	113	Census Tract 13.02
345	113	Census Tract 14
346	113	Census Tract 11.01
347	113	Census Tract 15.02
348	113	Census Tract 15.03
349	113	Census Tract 16
350	113	Census Tract 17.01
351	113	Census Tract 122.09
352	113	Census Tract 166.20

Census Tracts Contained within the DWU Service Area

ID	County ID	Census Tract Name
353	113	Census Tract 167.01
354	113	Census Tract 162.02
355	113	Census Tract 164.09
356	113	Census Tract 110.01
357	113	Census Tract 93.03
358	113	Census Tract 86.03
359	113	Census Tract 169.02
360	113	Census Tract 116.01
361	113	Census Tract 90
362	113	Census Tract 193.02
363	113	Census Tract 146.01
364	113	Census Tract 46
365	113	Census Tract 71.02
366	113	Census Tract 78.20
367	113	Census Tract 72.01
368	113	Census Tract 72.02
369	113	Census Tract 73.01
370	113	Census Tract 73.02
371	113	Census Tract 37
372	113	Census Tract 78.10
373	113	Census Tract 79.03
374	113	Census Tract 79.06
375	113	Census Tract 38
376	113	Census Tract 39.01
377	113	Census Tract 168.02
378	113	Census Tract 167.04
379	113	Census Tract 167.05
380	113	Census Tract 87.05
381	113	Census Tract 107.01
382	113	Census Tract 139.01
383	113	Census Tract 39.02
384	113	Census Tract 40
385	113	Census Tract 41
386	113	Census Tract 42.02
387	113	Census Tract 43
388	113	Census Tract 44
389	113	Census Tract 45
390	121	Census Tract 219
391	121	Census Tract 215.22
392	121	Census Tract 205.05
393	121	Census Tract 217.46
394	121	Census Tract 217.19
395	121	Census Tract 217.47
396	121	Census Tract 213.05

Census Tracts Contained within the DWU Service Area

ID	County ID	Census Tract Name
397	121	Census Tract 212.02
398	121	Census Tract 214.08
399	121	Census Tract 213.03
400	121	Census Tract 216.18
401	121	Census Tract 215.17
402	121	Census Tract 217.45
403	121	Census Tract 217.44
404	121	Census Tract 217.16
405	121	Census Tract 215.14
406	121	Census Tract 217.17
407	121	Census Tract 217.15
408	121	Census Tract 217.21
409	121	Census Tract 215.16
410	121	Census Tract 215.18
411	121	Census Tract 215.19
412	121	Census Tract 216.29
413	121	Census Tract 216.21
414	121	Census Tract 215.21
415	121	Census Tract 217.23
416	121	Census Tract 217.30
417	121	Census Tract 217.40
418	085	Census Tract 317.17
419	121	Census Tract 216.30
420	113	Census Tract 136.15
421	113	Census Tract 136.17
422	113	Census Tract 136.19
423	439	Census Tract 1139.07
424	121	Census Tract 217.39
425	121	Census Tract 216.33
426	121	Census Tract 216.28
427	121	Census Tract 216.32
428	121	Census Tract 216.35
429	121	Census Tract 216.34
430	113	Census Tract 137.14
431	113	Census Tract 137.15
432	113	Census Tract 137.16
433	113	Census Tract 137.18
434	113	Census Tract 137.19
435	113	Census Tract 137.20
436	121	Census Tract 216.38
437	439	Census Tract 1113.10
438	439	Census Tract 1115.47
439	439	Census Tract 1219.04
440	113	Census Tract 137.21

Census Tracts Contained within the DWU Service Area

ID	County ID	Census Tract Name
441	113	Census Tract 137.22
442	113	Census Tract 137.25
443	085	Census Tract 317.06
444	121	Census Tract 216.20
445	121	Census Tract 201.06
446	121	Census Tract 215.25
447	121	Census Tract 214.04
448	121	Census Tract 203.09
449	121	Census Tract 203.07
450	121	Census Tract 217.50
451	121	Census Tract 216.24
452	121	Census Tract 217.42
453	121	Census Tract 201.11
454	121	Census Tract 202.03
455	121	Census Tract 201.03
456	121	Census Tract 201.07
457	121	Census Tract 216.37
458	121	Census Tract 217.43
459	121	Census Tract 217.27
460	439	Census Tract 1136.31
461	439	Census Tract 1137.11
462	113	Census Tract 138.03
463	113	Census Tract 138.04
464	113	Census Tract 139.02
465	113	Census Tract 140.01
466	113	Census Tract 141.03
467	085	Census Tract 317.08
468	113	Census Tract 190.40
469	113	Census Tract 185.06
470	113	Census Tract 109.04
471	113	Census Tract 141.32
472	121	Census Tract 201.10
473	121	Census Tract 216.26
474	121	Census Tract 217.37
475	121	Census Tract 217.38
476	121	Census Tract 217.35
477	439	Census Tract 1131.16
478	121	Census Tract 216.31
479	113	Census Tract 141.13
480	113	Census Tract 141.15
481	113	Census Tract 141.16
482	085	Census Tract 317.09
483	439	Census Tract 1137.07
484	439	Census Tract 1115.36

Census Tracts Contained within the DWU Service Area

ID	County ID	Census Tract Name
485	439	Census Tract 1139.27
486	121	Census Tract 217.33
487	121	Census Tract 217.34
488	121	Census Tract 217.32
489	121	Census Tract 217.31
490	121	Census Tract 217.29
491	121	Census Tract 217.26
492	439	Census Tract 1135.20
493	113	Census Tract 141.19
494	113	Census Tract 141.20
495	113	Census Tract 141.23
496	113	Census Tract 141.26
497	439	Census Tract 1131.13
498	439	Census Tract 1136.34
499	121	Census Tract 201.12
500	121	Census Tract 205.03
501	121	Census Tract 212.01
502	121	Census Tract 214.07
503	121	Census Tract 217.25
504	439	Census Tract 1136.32
505	439	Census Tract 1137.10
506	439	Census Tract 1219.03
507	439	Census Tract 1131.14
508	439	Census Tract 1135.18
509	439	Census Tract 1137.09
510	113	Census Tract 142.03
511	113	Census Tract 142.04
512	113	Census Tract 143.02
513	113	Census Tract 143.06
514	113	Census Tract 143.07
515	439	Census Tract 1115.39
516	121	Census Tract 217.22
517	085	Census Tract 318.04
518	121	Census Tract 217.49
519	121	Census Tract 217.51
520	121	Census Tract 217.52
521	121	Census Tract 215.20
522	121	Census Tract 218
523	113	Census Tract 125
524	113	Census Tract 126.01
525	113	Census Tract 127.01
526	113	Census Tract 127.02
527	113	Census Tract 128
528	113	Census Tract 129

Census Tracts Contained within the DWU Service Area

ID	County ID	Census Tract Name
529	113	Census Tract 143.10
530	113	Census Tract 144.03
531	113	Census Tract 144.05
532	113	Census Tract 144.06
533	113	Census Tract 144.07
534	113	Census Tract 144.08
535	113	Census Tract 143.09
536	113	Census Tract 136.20
537	113	Census Tract 64.02
538	439	Census Tract 1065.18
539	113	Census Tract 108.04
540	113	Census Tract 108.05
541	113	Census Tract 64.01
542	113	Census Tract 131.05
543	113	Census Tract 131.04
544	113	Census Tract 78.23
545	113	Census Tract 78.22
546	113	Census Tract 78.21
547	113	Census Tract 130.11
548	113	Census Tract 78.27
549	113	Census Tract 130.04
550	113	Census Tract 130.05
551	113	Census Tract 130.07
552	113	Census Tract 130.08
553	113	Census Tract 130.09
554	113	Census Tract 131.01
555	113	Census Tract 78.26
556	113	Census Tract 78.24
557	113	Census Tract 78.25
558	113	Census Tract 131.02
559	113	Census Tract 145.01
560	113	Census Tract 145.02
561	113	Census Tract 146.02
562	113	Census Tract 147.01
563	113	Census Tract 147.02
564	113	Census Tract 149.01
565	113	Census Tract 149.02
566	113	Census Tract 79.10
567	113	Census Tract 79.09
568	113	Census Tract 138.06
569	113	Census Tract 137.27
570	113	Census Tract 142.05
571	113	Census Tract 143.12
572	113	Census Tract 141.37

Census Tracts Contained within the DWU Service Area

ID	County ID	Census Tract Name
573	113	Census Tract 164.12
574	113	Census Tract 164.13
575	113	Census Tract 132
576	113	Census Tract 133
577	113	Census Tract 134
578	113	Census Tract 135
579	113	Census Tract 136.05
580	113	Census Tract 136.06
581	113	Census Tract 136.08
582	113	Census Tract 150
583	113	Census Tract 151
584	113	Census Tract 152.02
585	113	Census Tract 152.04
586	113	Census Tract 152.05
587	113	Census Tract 152.06
588	113	Census Tract 153.03
589	113	Census Tract 153.05
590	439	Census Tract 1130.01
591	113	Census Tract 91.01
592	439	Census Tract 1115.37
593	113	Census Tract 94.01
594	113	Census Tract 94.02
595	113	Census Tract 95
596	439	Census Tract 1136.10
597	439	Census Tract 1139.09
598	439	Census Tract 1141.03
599	439	Census Tract 1135.19
600	439	Census Tract 1139.26
601	439	Census Tract 9800
602	439	Census Tract 1115.48
603	439	Census Tract 1136.33
604	439	Census Tract 1115.49
605	439	Census Tract 1113.14
606	439	Census Tract 1113.13
607	113	Census Tract 126.03
608	113	Census Tract 204
609	085	Census Tract 317.18
610	113	Census Tract 4.06
611	113	Census Tract 165.20
612	113	Census Tract 142.06
613	113	Census Tract 141.38
614	113	Census Tract 141.30
615	113	Census Tract 79.12
616	113	Census Tract 138.05

Census Tracts Contained within the DWU Service Area

ID	County ID	Census Tract Name
617	113	Census Tract 165.21
618	113	Census Tract 185.05
619	113	Census Tract 141.31
620	113	Census Tract 9800
621	113	Census Tract 79.13
622	113	Census Tract 200
623	121	Census Tract 215.24
624	121	Census Tract 217.41
625	121	Census Tract 217.24
626	121	Census Tract 217.53
627	121	Census Tract 201.04
628	121	Census Tract 201.08
629	121	Census Tract 201.13
630	121	Census Tract 201.05
631	121	Census Tract 217.36
632	121	Census Tract 214.06
633	121	Census Tract 203.10
634	121	Census Tract 217.48
635	121	Census Tract 215.12
636	121	Census Tract 201.09
637	121	Census Tract 215.26
638	113	Census Tract 136.16
639	113	Census Tract 190.18
640	113	Census Tract 157
641	113	Census Tract 160.01
642	113	Census Tract 160.02
643	113	Census Tract 161
644	113	Census Tract 162.01
645	257	Census Tract 508
646	113	Census Tract 163.01
647	113	Census Tract 164.01
648	113	Census Tract 164.08
649	113	Census Tract 164.10
650	113	Census Tract 164.11
651	113	Census Tract 165.02
652	113	Census Tract 163.02
653	113	Census Tract 165.09
654	113	Census Tract 165.10
655	113	Census Tract 165.11
656	113	Census Tract 166.15
657	113	Census Tract 166.16

Census Tracts Contained within the TRWD Service Area

ID	County ID	Census Tract Name
1	439	Census Tract 1138.09
2	439	Census Tract 1216.09
3	251	Census Tract 1302.13
4	251	Census Tract 1302.12
5	251	Census Tract 1302.10
6	251	Census Tract 1303.04
7	251	Census Tract 1302.11
8	251	Census Tract 1303.03
9	251	Census Tract 1302.14
10	251	Census Tract 1304.07
11	439	Census Tract 1028
12	439	Census Tract 1115.22
13	439	Census Tract 1024.01
14	439	Census Tract 1131.09
15	367	Census Tract 1407.06
16	367	Census Tract 1404.08
17	367	Census Tract 1401.02
18	367	Census Tract 1404.09
19	367	Census Tract 1407.03
20	367	Census Tract 1401.01
21	439	Census Tract 1136.11
22	113	Census Tract 154.01
23	113	Census Tract 154.03
24	113	Census Tract 154.04
25	251	Census Tract 1302.05
26	251	Census Tract 1302.08
27	251	Census Tract 1304.09
28	439	Census Tract 1107.03
29	439	Census Tract 1136.28
30	439	Census Tract 1136.29
31	113	Census Tract 170.01
32	113	Census Tract 169.03
33	439	Census Tract 1037.01
34	439	Census Tract 1038
35	439	Census Tract 1037.02
36	257	Census Tract 512.02
37	257	Census Tract 512.01
38	439	Census Tract 1035
39	439	Census Tract 1046.02
40	439	Census Tract 1046.04
41	439	Census Tract 1041
42	439	Census Tract 1042.01
43	439	Census Tract 1042.02
44	439	Census Tract 1043

Census Tracts Contained within the TRWD Service Area

ID	County ID	Census Tract Name
45	439	Census Tract 1044
46	439	Census Tract 1045.04
47	439	Census Tract 1045.05
48	439	Census Tract 1046.01
49	439	Census Tract 1115.16
50	439	Census Tract 1046.03
51	439	Census Tract 1139.16
52	439	Census Tract 1115.05
53	439	Census Tract 1115.21
54	439	Census Tract 1142.05
55	439	Census Tract 1138.10
56	439	Census Tract 1022.01
57	439	Census Tract 1135.14
58	121	Census Tract 202.02
59	121	Census Tract 203.05
60	439	Census Tract 1065.11
61	439	Census Tract 1065.12
62	439	Census Tract 1065.13
63	439	Census Tract 1065.14
64	439	Census Tract 1065.15
65	439	Census Tract 1065.16
66	439	Census Tract 1066
67	439	Census Tract 1114.04
68	439	Census Tract 1046.05
69	439	Census Tract 1048.02
70	439	Census Tract 1050.01
71	439	Census Tract 1110.13
72	439	Census Tract 1050.06
73	439	Census Tract 1052.01
74	439	Census Tract 1052.04
75	439	Census Tract 1052.05
76	439	Census Tract 1054.03
77	439	Census Tract 1054.04
78	439	Census Tract 1054.05
79	439	Census Tract 1054.06
80	439	Census Tract 1055.02
81	439	Census Tract 1115.06
82	439	Census Tract 1115.13
83	439	Census Tract 1115.14
84	439	Census Tract 1055.03
85	439	Census Tract 1055.05
86	439	Census Tract 1055.08
87	439	Census Tract 1055.10
88	439	Census Tract 1055.11

Census Tracts Contained within the TRWD Service Area

ID	County ID	Census Tract Name
89	439	Census Tract 1055.12
90	439	Census Tract 1056
91	439	Census Tract 1057.01
92	439	Census Tract 1057.03
93	439	Census Tract 1057.04
94	439	Census Tract 1058
95	439	Census Tract 1111.02
96	439	Census Tract 1112.02
97	439	Census Tract 1113.04
98	439	Census Tract 1060.01
99	439	Census Tract 1060.02
100	439	Census Tract 1061.01
101	439	Census Tract 1061.02
102	439	Census Tract 1062.01
103	439	Census Tract 1062.02
104	439	Census Tract 1063
105	439	Census Tract 1065.02
106	439	Census Tract 1065.03
107	439	Census Tract 1065.07
108	439	Census Tract 1065.10
109	139	Census Tract 605
110	139	Census Tract 606
111	139	Census Tract 614
112	139	Census Tract 613
113	139	Census Tract 602.07
114	139	Census Tract 615
115	139	Census Tract 616
116	139	Census Tract 617
117	139	Census Tract 609
118	139	Census Tract 602.04
119	139	Census Tract 610
120	139	Census Tract 603
121	139	Census Tract 601.01
122	139	Census Tract 604
123	139	Census Tract 612
124	139	Census Tract 611
125	139	Census Tract 601.02
126	139	Census Tract 602.06
127	251	Census Tract 1302.15
128	349	Census Tract 9709
129	349	Census Tract 9702
130	349	Census Tract 9703
131	349	Census Tract 9708
132	349	Census Tract 9707

Census Tracts Contained within the TRWD Service Area

ID	County ID	Census Tract Name
133	349	Census Tract 9705
134	349	Census Tract 9706
135	349	Census Tract 9701
136	349	Census Tract 9704
137	349	Census Tract 9710
138	439	Census Tract 1139.06
139	439	Census Tract 1139.10
140	439	Census Tract 1140.03
141	439	Census Tract 1222
142	439	Census Tract 1223
143	439	Census Tract 1224
144	439	Census Tract 1225
145	213	Census Tract 9504
146	213	Census Tract 9510
147	213	Census Tract 9511
148	213	Census Tract 9508
149	213	Census Tract 9507
150	213	Census Tract 9505
151	213	Census Tract 9513
152	213	Census Tract 9503
153	213	Census Tract 9512
154	439	Census Tract 1226
155	439	Census Tract 1140.05
156	439	Census Tract 1216.01
157	439	Census Tract 1216.04
158	439	Census Tract 1140.06
159	139	Census Tract 602.13
160	139	Census Tract 602.11
161	139	Census Tract 608.01
162	139	Census Tract 607.02
163	139	Census Tract 602.14
164	139	Census Tract 607.03
165	139	Census Tract 608.02
166	139	Census Tract 608.03
167	139	Census Tract 607.01
168	139	Census Tract 602.08
169	139	Census Tract 602.12
170	139	Census Tract 602.10
171	139	Census Tract 602.09
172	497	Census Tract 1501.01
173	497	Census Tract 1504.02
174	497	Census Tract 1503
175	497	Census Tract 1506.01
176	497	Census Tract 1502

Census Tracts Contained within the TRWD Service Area

ID	County ID	Census Tract Name
177	497	Census Tract 1506.03
178	497	Census Tract 1504.01
179	497	Census Tract 1505
180	497	Census Tract 1506.02
181	497	Census Tract 1501.02
182	497	Census Tract 1504.03
183	121	Census Tract 203.06
184	439	Census Tract 1114.02
185	439	Census Tract 1115.31
186	439	Census Tract 1115.32
187	439	Census Tract 1115.33
188	439	Census Tract 1115.34
189	439	Census Tract 1115.38
190	439	Census Tract 1138.03
191	439	Census Tract 1138.08
192	439	Census Tract 1115.45
193	439	Census Tract 1115.46
194	439	Census Tract 1131.02
195	439	Census Tract 1131.04
196	439	Census Tract 1131.07
197	439	Census Tract 1132.12
198	439	Census Tract 1132.13
199	439	Census Tract 1132.14
200	439	Census Tract 1132.15
201	439	Census Tract 1132.16
202	439	Census Tract 1132.17
203	439	Census Tract 1136.24
204	439	Census Tract 1136.25
205	439	Census Tract 1136.26
206	439	Census Tract 1136.27
207	439	Census Tract 1136.30
208	439	Census Tract 1137.03
209	439	Census Tract 1136.23
210	439	Census Tract 1229
211	439	Census Tract 1107.04
212	113	Census Tract 165.23
213	113	Census Tract 166.23
214	113	Census Tract 166.22
215	251	Census Tract 1305
216	251	Census Tract 1301
217	251	Census Tract 1302.07
218	251	Census Tract 1302.04
219	251	Census Tract 1304.05
220	251	Census Tract 1304.08

Census Tracts Contained within the TRWD Service Area

ID	County ID	Census Tract Name
221	251	Census Tract 1304.06
222	251	Census Tract 1304.10
223	439	Census Tract 1001.01
224	439	Census Tract 1137.05
225	439	Census Tract 1065.09
226	439	Census Tract 1109.06
227	439	Census Tract 1134.03
228	439	Census Tract 1142.04
229	439	Census Tract 1027
230	439	Census Tract 1138.11
231	439	Census Tract 1217.04
232	439	Census Tract 1130.02
233	439	Census Tract 1064
234	439	Census Tract 1060.04
235	439	Census Tract 1036.02
236	367	Census Tract 1404.07
237	367	Census Tract 1404.05
238	367	Census Tract 1402
239	367	Census Tract 1403
240	367	Census Tract 1404.03
241	121	Census Tract 202.04
242	121	Census Tract 203.08
243	439	Census Tract 1109.01
244	439	Census Tract 1109.03
245	367	Census Tract 1405.02
246	367	Census Tract 1404.11
247	367	Census Tract 1405.01
248	367	Census Tract 1404.10
249	367	Census Tract 1407.04
250	367	Census Tract 1407.05
251	113	Census Tract 168.02
252	439	Census Tract 1135.16
253	439	Census Tract 1136.07
254	439	Census Tract 1136.12
255	439	Census Tract 1136.13
256	237	Census Tract 9505
257	439	Census Tract 1136.18
258	213	Census Tract 9509.01
259	213	Census Tract 9506.02
260	213	Census Tract 9509.02
261	213	Census Tract 9509.03
262	213	Census Tract 9506.01
263	439	Census Tract 1136.19
264	439	Census Tract 1023.01

Census Tracts Contained within the TRWD Service Area

ID	County ID	Census Tract Name
265	439	Census Tract 1023.02
266	439	Census Tract 1024.02
267	439	Census Tract 1025
268	439	Census Tract 1008
269	439	Census Tract 1009
270	439	Census Tract 1012.01
271	439	Census Tract 1012.02
272	439	Census Tract 1013.01
273	439	Census Tract 1014.01
274	439	Census Tract 1014.03
275	439	Census Tract 1015
276	439	Census Tract 1017
277	439	Census Tract 1014.02
278	439	Census Tract 1136.22
279	439	Census Tract 1001.02
280	439	Census Tract 1002.01
281	439	Census Tract 1002.02
282	439	Census Tract 1003
283	439	Census Tract 1004
284	439	Census Tract 1005.01
285	439	Census Tract 1005.02
286	439	Census Tract 1020
287	439	Census Tract 1021
288	439	Census Tract 1022.02
289	439	Census Tract 1110.05
290	439	Census Tract 1110.03
291	439	Census Tract 1110.08
292	439	Census Tract 1139.07
293	439	Census Tract 1131.10
294	439	Census Tract 1006.02
295	439	Census Tract 1113.12
296	439	Census Tract 1113.07
297	439	Census Tract 1114.06
298	439	Census Tract 1113.10
299	439	Census Tract 1115.47
300	439	Census Tract 1235
301	439	Census Tract 1234
302	439	Census Tract 1113.08
303	439	Census Tract 1219.04
304	439	Census Tract 1115.53
305	439	Census Tract 1228.01
306	439	Census Tract 1115.52
307	439	Census Tract 1220.01
308	439	Census Tract 1220.02

Census Tracts Contained within the TRWD Service Area

ID	County ID	Census Tract Name
309	439	Census Tract 1131.15
310	439	Census Tract 1142.06
311	439	Census Tract 1138.12
312	439	Census Tract 1139.21
313	121	Census Tract 203.09
314	121	Census Tract 203.07
315	439	Census Tract 1139.28
316	439	Census Tract 1139.23
317	439	Census Tract 1110.16
318	439	Census Tract 1110.15
319	439	Census Tract 1228.02
320	439	Census Tract 1136.31
321	439	Census Tract 1137.11
322	439	Census Tract 1139.22
323	439	Census Tract 1233
324	439	Census Tract 1142.07
325	439	Census Tract 1111.04
326	439	Census Tract 1219.05
327	439	Census Tract 1131.16
328	439	Census Tract 1108.09
329	439	Census Tract 1231
330	439	Census Tract 1013.02
331	439	Census Tract 1106
332	439	Census Tract 1108.06
333	439	Census Tract 1111.03
334	439	Census Tract 1137.07
335	439	Census Tract 1107.01
336	439	Census Tract 1115.36
337	439	Census Tract 1216.06
338	439	Census Tract 1139.11
339	439	Census Tract 1142.03
340	439	Census Tract 1049
341	161	Census Tract 3
342	161	Census Tract 2
343	161	Census Tract 1
344	161	Census Tract 7
345	161	Census Tract 6
346	161	Census Tract 4
347	439	Census Tract 1138.13
348	439	Census Tract 1026.02
349	439	Census Tract 1026.01
350	439	Census Tract 1139.27
351	439	Census Tract 1048.04
352	439	Census Tract 1139.19

Census Tracts Contained within the TRWD Service Area

ID	County ID	Census Tract Name
353	439	Census Tract 1139.24
354	439	Census Tract 1139.25
355	439	Census Tract 1132.20
356	439	Census Tract 1132.21
357	439	Census Tract 1135.20
358	439	Census Tract 1048.03
359	439	Census Tract 1047.02
360	113	Census Tract 141.26
361	439	Census Tract 1059.02
362	439	Census Tract 1050.08
363	439	Census Tract 1050.07
364	439	Census Tract 1055.14
365	439	Census Tract 1055.13
366	439	Census Tract 1131.13
367	439	Census Tract 1136.34
368	439	Census Tract 1110.18
369	439	Census Tract 1112.04
370	439	Census Tract 1065.17
371	439	Census Tract 1115.23
372	439	Census Tract 1115.24
373	439	Census Tract 1115.25
374	439	Census Tract 1115.26
375	439	Census Tract 1115.29
376	439	Census Tract 1115.30
377	439	Census Tract 1136.32
378	439	Census Tract 1137.10
379	439	Census Tract 1047.01
380	439	Census Tract 1139.18
381	439	Census Tract 1110.17
382	439	Census Tract 1219.03
383	439	Census Tract 1131.14
384	439	Census Tract 1135.17
385	439	Census Tract 1135.18
386	439	Census Tract 1137.09
387	439	Census Tract 1139.17
388	439	Census Tract 1113.09
389	439	Census Tract 1059.01
390	439	Census Tract 1232
391	439	Census Tract 1230
392	439	Census Tract 1236
393	439	Census Tract 1115.39
394	439	Census Tract 1115.40
395	439	Census Tract 1115.41
396	439	Census Tract 1115.42

Census Tracts Contained within the TRWD Service Area

ID	County ID	Census Tract Name
397	439	Census Tract 1108.05
398	439	Census Tract 1115.43
399	439	Census Tract 1115.44
400	439	Census Tract 1115.50
401	439	Census Tract 1114.08
402	439	Census Tract 1115.51
403	439	Census Tract 1113.11
404	439	Census Tract 1131.08
405	439	Census Tract 1131.11
406	439	Census Tract 1131.12
407	439	Census Tract 1132.06
408	439	Census Tract 1132.07
409	439	Census Tract 1108.07
410	113	Census Tract 144.03
411	439	Census Tract 1132.18
412	439	Census Tract 1133.01
413	439	Census Tract 1133.02
414	439	Census Tract 1134.05
415	439	Census Tract 1134.07
416	439	Census Tract 1134.08
417	439	Census Tract 1065.18
418	439	Census Tract 1139.29
419	439	Census Tract 1135.09
420	439	Census Tract 1135.10
421	439	Census Tract 1135.11
422	439	Census Tract 1135.12
423	439	Census Tract 1135.13
424	113	Census Tract 153.03
425	439	Census Tract 1055.07
426	439	Census Tract 1109.07
427	439	Census Tract 1139.12
428	439	Census Tract 1110.11
429	439	Census Tract 1130.01
430	439	Census Tract 1109.05
431	439	Census Tract 1216.10
432	439	Census Tract 1114.05
433	439	Census Tract 1006.01
434	439	Census Tract 1139.08
435	439	Census Tract 1007
436	439	Census Tract 1045.02
437	439	Census Tract 1113.06
438	439	Census Tract 1115.37
439	439	Census Tract 1132.10
440	439	Census Tract 1110.10

Census Tracts Contained within the TRWD Service Area

ID	County ID	Census Tract Name
441	439	Census Tract 1113.01
442	439	Census Tract 1110.12
443	439	Census Tract 1052.03
444	439	Census Tract 1136.10
445	439	Census Tract 1139.09
446	439	Census Tract 1102.04
447	439	Census Tract 1103.01
448	439	Census Tract 1103.02
449	439	Census Tract 1104.02
450	439	Census Tract 1105
451	439	Census Tract 1141.04
452	439	Census Tract 1141.03
453	439	Census Tract 1138.16
454	439	Census Tract 1138.15
455	439	Census Tract 1108.08
456	439	Census Tract 1135.19
457	439	Census Tract 1140.08
458	439	Census Tract 1139.26
459	439	Census Tract 9800
460	439	Census Tract 1139.20
461	439	Census Tract 1114.07
462	439	Census Tract 1114.09
463	439	Census Tract 1115.48
464	439	Census Tract 1219.06
465	439	Census Tract 1138.14
466	439	Census Tract 1136.33
467	439	Census Tract 1140.07
468	439	Census Tract 1112.03
469	439	Census Tract 1115.49
470	439	Census Tract 1113.14
471	439	Census Tract 1113.13
472	113	Census Tract 9800
473	113	Census Tract 200
474	439	Census Tract 1067
475	439	Census Tract 1101.01
476	439	Census Tract 1101.02
477	439	Census Tract 1102.03
478	237	Census Tract 9503
479	237	Census Tract 9501
480	439	Census Tract 1216.05
481	439	Census Tract 1216.08
482	439	Census Tract 1216.11
483	439	Census Tract 1217.02
484	439	Census Tract 1217.03

Census Tracts Contained within the TRWD Service Area

ID	County ID	Census Tract Name
485	439	Census Tract 1036.01
486	439	Census Tract 1141.02
487	439	Census Tract 1104.01
488	439	Census Tract 1134.04
489	439	Census Tract 1221
490	439	Census Tract 1227
491	439	Census Tract 1045.03
492	439	Census Tract 1102.02
493	113	Census Tract 161
494	257	Census Tract 513
495	257	Census Tract 508
496	113	Census Tract 164.01
497	113	Census Tract 164.10
498	113	Census Tract 164.11
499	113	Census Tract 166.16

Projected Population for Customers of Dallas

WUGs	2011 Population Revisions Applied to DWU					
	2010	2020	2030	2040	2050	2060
Addison	16,000	20,534	22,358	23,629	24,515	25,133
Carrollton	121,000	124,000	128,500	131,320	133,450	134,800
Hebron	500	500	500	500	500	500
Cedar Hill	45,006	65,460	76,836	80,316	80,316	80,316
Cockrell Hill	4,782	4,947	5,028	5,067	5,086	5,095
Coppell	40,415	40,577	40,715	40,832	40,932	41,016
Dallas	1,312,324	1,415,000	1,495,000	1,598,223	1,764,681	2,058,767
Balch Springs	21,083	22,564	23,849	24,963	25,930	26,768
Dallas County - Other	737	572	444	339	267	201
Denton	0	0	34,265	89,385	156,342	288,625
DeSoto	47,649	57,243	65,849	73,881	82,923	85,400
Duncanville	37,100	37,100	37,100	37,100	37,100	37,100
Farmers Branch	30,470	33,161	35,608	37,833	39,855	41,693
Flower Mound	33,334	34,000	35,712	35,712	35,712	35,712
Glenn Heights	11,423	13,833	16,516	19,102	21,705	24,332
Oak Leaf	1,257	1,526	1,791	2,064	2,368	2,705
Grand Prairie	138,890	79,184	109,037	135,988	164,725	164,725
Grapevine	11,503	10,725	10,680	9,600	8,820	8,220
Hutchins	3,200	4,000	5,000	6,500	8,500	14,000
Wilmer	1,037	1,712	2,465	4,740	11,242	19,228
Irving	59,413	67,228	14,584	14,459	14,390	14,460
Lancaster	37,392	59,067	64,648	64,648	64,648	64,648
Lewisville	97,709	110,002	122,002	136,002	155,002	176,515
Denton County FWSD NO. 1A	309	1,634	2,211	2,805	3,408	4,039
Ovilla	3,634	5,851	8,066	10,287	10,829	11,621
Red Oak	10,000	17,850	23,400	26,600	28,500	30,400
Seagoville	13,017	16,327	19,537	22,848	25,536	27,517
Combine WSC	4,122	5,737	7,202	8,795	10,785	13,285
Combine	2,393	2,969	3,474	4,019	4,702	5,563
The Colony	36,450	50,400	56,700	58,500	60,300	60,840
UTRWD	72,061	287,544	322,273	331,711	339,917	346,339
UTRWD Add'l						63,290
Total	**2,214,210**	**2,591,247**	**2,791,350**	**3,037,768**	**3,362,986**	**3,912,853**

Projected Population for Customers of Tarrant Regional Water District

WUGs	2011 Population Revisions Applied to TRWD					
	2010	2020	2030	2040	2050	2060
Arlington	331,146	373,575	398,700	421,082	421,554	422,498
Grand Prairie (through Arlington)	0	44,799	44,799	44,799	44,799	44,799
Bethesda WSC	0	10,551	13,196	16,069	19,598	23,900
Azle	12,108	16,795	23,473	31,060	38,682	45,362
Benbrook	18,912	27,000	30,000	36,000	43,000	51,000
Blue Mound	0	0	0	0	0	0
Bridgeport	5,900	8,352	12,001	14,296	16,657	19,936
Community WSC	3,536	3,588	3,642	3,699	3,767	3,847
Decatur	6,804	8,508	11,738	15,253	19,751	23,225
East Cedar Creek FWSD	9,973	11,178	13,363	14,568	15,773	16,978
Gun Barrel City	3,066	4,321	4,954	5,603	6,395	7,394
Fort Worth	732,201	926,822	1,127,326	1,379,008	1,696,962	2,085,879
Aledo	0	2,675	6,138	9,616	10,262	10,262
Bethesda WSC	24,111	21,117	26,383	32,129	39,172	47,768
Burleson	32,091	48,255	60,336	61,782	63,517	65,567
Crowley	8,190	10,549	14,181	20,246	25,128	27,589
Dalworthington Gardens	1,616	1,786	1,901	1,969	2,020	2,052
Denton County-Other	2,137	2,822	3,271	3,686	4,090	4,506
Edgecliff	2,550	2,550	2,550	2,550	2,550	2,550
Everman	1,922	2,198	2,072	1,940	1,901	1,901
Forest Hill	12,000	13,090	14,210	15,392	16,738	17,574
Grand Prairie	6,460	89,180	90,787	91,265	90,642	90,642
Haltom City	41,000	50,322	53,058	54,428	55,113	55,456
Haslet	1,692	3,688	6,685	6,685	6,685	6,685
Hurst	34,635	36,695	36,654	36,572	36,531	36,531
Keller	40,127	45,026	51,310	51,310	51,310	51,310
Kennedale	483	2,420	3,378	4,048	4,476	4,802
Lake Worth	3,053	3,553	4,122	4,686	5,278	5,573
North Richland Hills	18,226	20,801	22,533	23,737	24,496	25,009
Watauga	23,423	24,632	25,000	25,000	25,000	25,000
Northlake	1,700	2,487	2,877	5,530	8,182	9,842
Richland Hills	5,477	5,985	6,518	7,148	7,522	7,682
Roanoke	5,971	9,132	12,199	15,282	20,642	25,228
Saginaw	18,813	22,803	25,711	27,829	29,373	30,499
Sansom Park Village	372	426	437	417	442	495
Southlake (Tarrant & Denton Co)	28,019	29,636	30,107	31,924	34,188	36,000
Tarrant County-Other	12,936	12,697	12,505	12,219	12,123	12,123
Trophy Club	6,025	7,064	7,954	8,730	9,568	10,416
Westover Hills	658	658	658	658	658	658
Westworth Village	3,224	3,403	3,618	3,869	4,156	4,586
White Settlement	9,512	10,540	11,394	12,236	13,694	15,180
Kemp	1,400	1,700	2,000	2,000	2,000	2,000
Mabank (Henderson & Kaufman Co.)	3,074	3,729	4,401	5,142	6,058	7,194
GBC (added by LPB)	3,065	2,880	3,302	3,735	4,263	4,930
Malakoff	1,195	1,265	1,339	1,409	1,502	1,614
Mansfield	57,337	87,375	108,258	123,658	139,058	154,458
Johnson County SUD	8,791	17,242	33,744	32,640	31,639	31,628
Grand Prairie	0	67,198	79,202	89,146	99,604	99,604
River Oaks	7,100	7,100	7,100	7,100	7,100	7,100
Runaway Bay	1,411	1,720	2,097	2,400	2,700	3,000
Springtown	1,596	2,568	3,540	4,524	5,516	6,512
Reno	1,223	1,284	1,329	1,362	1,427	1,515
Trinity River Authority	0	0	0	0	0	0
Bedford	44,551	46,841	48,749	50,320	51,710	52,900
Buena Vista Bethel SUD	2,901	4,089	5,487	7,075	8,811	10,701
Ennis (by 2030)	103	105	101	2,154	15,827	23,226
Community Water Company (Ellis County)	0	1,414	1,690	1,972	2,288	0
Rice WSC	0	417	421	429	429	0
Ellis County-Other (by 2020)	0	299	303	305	31	0
Ferris (by 2020)	1,142	1,476	1,839	2,305	2,880	3,380
Palmer (by 2020)	0	0	0	0	0	0
Italy (by 2020)	0	356	638	953	1,329	1,768
Euless	45,803	52,622	55,936	57,553	58,287	58,715
North Richland Hills	45,403	51,452	55,539	58,300	60,166	61,426
Maypearl (by 2020)	0	0	0	0	0	0
Midlothian	0	13,368	26,851	38,932	51,987	65,131
Grand Prairie	0	72,803	85,808	96,581	107,912	107,912
Venus (Region G)	2,435	2,435	2,435	2,435	2,435	2,435
Rockett SUD	21,073	29,038	41,003	50,936	56,255	56,890
Oak Leaf	245	248	251	252	254	255
Lancaster	608	597	653	653	653	653
Red Oak	625	1,050	1,300	1,400	1,500	1,600
Pecan Hill	813	943	1,072	1,203	1,350	1,512
Waxahachie	30,000	39,000	46,342	59,322	75,937	97,206
Colleyville	22,099	25,564	25,536	25,536	25,536	25,536

WUGs	2011 Population Revisions Applied to TRWD					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
Grapevine	28,398	32,230	36,840	37,620	38,220	38,700
Walnut Creek SUD	21,343	31,654	50,123	62,000	65,500	68,000
Boyd	453	920	1,395	1,866	2,356	2,356
Rhome	953	1,969	3,621	5,322	7,022	8,723
New Fairview	0	407	956	1,513	2,145	2,876
Newark	0	482	1,027	1,968	3,121	4,880
Paradise	563	691	848	1,041	1,278	1,568
Sanctuary	715	1,675	2,435	2,875	3,305	3,708
Weatherford	12,390	18,414	23,825	28,984	34,531	40,770
Hudson Oaks (starting by 2010)	574	995	1,522	2,041	2,544	3,042
Parker County Other	0	1,867	1,915	1,933	1,825	1,715
West Cedar Creek MUD	17,100	22,567	28,089	34,021	41,323	50,443
Seven Points	1,402	1,681	1,956	2,238	2,582	3,016
Tool	2,618	2,990	3,357	3,733	4,192	4,771
West Wise Rural WSC	3,474	3,864	4,287	4,758	5,283	5,865
Chico	525	708	992	1,382	1,874	2,472
Freestone County Other	9,298	9,717	9,935	9,998	9,998	9,998
Henderson County-Other	401	398	398	395	399	399
Kaufman County-Other	2,753	2,753	2,753	2,753	2,753	2,753
Navarro County-Other	704	708	708	702	708	708
Wise County-Other	15,901	17,609	17,609	17,609	17,609	17,609
Subtotal - Existing	**1,893,627**	**2,614,156**	**3,064,595**	**3,510,804**	**4,007,407**	**4,543,477**
Potential Future Customers						
Annetta (through Weatherford)	0	185.368	487.557	748.688	1022.448	1343.448
Annetta South (through Weatherford)	0	40.128	129.582	199.432	290.857	392.64
Aurora (through Rhome through Walnut Creek SUD)	0	412.2	422	425.502	428.697	737.87
Bardwell	0	140.825	354.468	585.934	850.297	1146.208
Corsicana	0	0	4073.93384	6843.886067	10602.39923	15786.30941
Fairfield	0	0	0	30.5	800.4	1395
Files Valley SUD	0	986.3354037	992.3652695	1002.322206	1000.973574	993.5185185
Mountain Peak SUD	859.248	3296.246	3723.237	4901.607	7012.28	9741.187
Pantego	0	669.902	676.856	676.856	690.764	690.764
Pelican Bay	0	344.4	765.072	970.79	1243.644	1582.056
Sardis-Lone Elm WSC	0	10455.472	14385.848	14325.74	14305.704	14305.704
Willow Park	0	1115.49	3451.926	5140	6305.6	7104
Subtotal - Potential	859.248	17646.3664	29462.84511	35851.25727	44554.06381	55218.70493
TOTAL	**1,894,486**	**2,631,803**	**3,094,058**	**3,546,655**	**4,051,961**	**4,598,696**

Projected Demand for Customers of Dallas - Gross and Net

WUGs	Demand on DWU					
	2010	2020	2030	2040	2050	2060
Addison	7,904	10,074	10,919	11,514	11,918	12,218
Carrollton	25,887	26,113	26,772	27,065	27,356	27,632
Hebron	114	111	110	109	109	109
Cedar Hill	9,829	14,076	16,431	17,005	17,005	17,005
Cockrell Hill	653	687	681	670	667	668
Coppell	11,544	11,500	11,447	11,434	11,417	11,440
Dallas	374,848	399,421	416,979	442,190	486,268	567,304
Balch Springs	2,621	2,730	2,805	2,852	2,934	3,028
Dallas County - Other	95	73	55	40	30	23
Denton Total	0	0	7,051	18,243	31,801	58,323
DeSoto	10,355	12,375	14,162	15,807	17,741	18,271
Duncanville	7,605	7,563	7,522	7,439	7,356	7,356
Farmers Branch	11,229	12,109	12,883	13,603	14,286	14,945
Flower Mound	8,662	10,435	12,320	12,320	12,320	12,320
Glenn Heights	1,407	1,674	1,961	2,247	2,528	2,834
Oak Leaf	283	338	393	448	512	585
Grand Prairie Total	23,813	16,174	21,334	26,159	31,233	31,233
Grapevine Total	3,864	3,565	3,530	3,153	2,887	2,697
Hutchins	821	1,008	1,255	1,624	2,123	3,497
Wilmer	121	205	290	552	1,309	2,241
Irving	15,765	18,750	4,000	4,000	4,000	4,000
Lancaster	5,614	8,665	9,346	9,273	9,273	9,273
Lewisville	19,263	21,317	23,506	26,051	29,517	33,613
Denton County FWSD NO. 1A	99	522	704	892	1,084	1,285
Ovilla	936	1,494	2,043	2,592	2,728	2,929
Red Oak	1,893	3,419	4,430	5,006	5,331	5,687
Seagoville	2,085	2,542	3,019	3,480	3,890	4,191
Combine WSC	462	688	855	1,035	1,268	1,562
Combine	282	356	405	463	537	635
The Colony	5,185	7,000	7,748	7,929	8,105	8,178
UTRWD Current Contract	10,000	46,290	56,656	58,438	60,066	61,638
UTRWD Additional						11,210
Collin County Irrigation	2,950	2,950	2,950	2,950	2,950	2,950
Dallas County Irrigation	8,768	8,768	8,768	8,768	8,768	8,768
Dallas County - Manufacturing	24,904	27,587	30,038	32,276	34,093	34,298
Dallas County - Mining	298	304	303	303	303	303
Dallas County - Raw Water for Steam E	3,367	4,290	5,000	5,000	5,000	5,000
Denton County Irrigation	2,400	2,400	2,400	2,400	2,400	2,400
Denton County Manufacturing	427	496	563	632	692	752
Rockwall Co Irrigation	277	277	277	277	277	277
Total Current Customers	**606,630**	**688,346**	**731,911**	**786,239**	**862,082**	**992,678**
Potential Future Customers						
Crandall (direct or through Seagoville)	0	347	601	672	1,037	1,490
Total	**606,630**	**688,693**	**732,512**	**786,911**	**863,119**	**994,168**

Projected Municipal Demand for Customers of Tarrant Regional Water District

	2011 Revised Demand Applied to TRWD					
WUGs	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Arlington	67,540	74,913	79,067	82,535	82,156	82,306
Grand Prairie (through Arlington)	0.00	4,484.00	4,484.00	4,484.00	4,484.00	4,484.00
Bethesda WSC	0	1,489	1,833	2,214	2,678	3,266
Azle	1,953	2,633	3,602	4,697	5,849	6,860
Benbrook	4,409	6,140	6,721	7,984	9,489	11,254
Blue Mound	0	0	0	0	0	0
Bridgeport	1,361	1,899	2,702	3,187	3,713	4,444
Community WSC	444	438	433	422	426	435
Decatur	1,639	2,011	2,748	3,537	4,580	5,385
East Cedar Creek FWSD	1,698	1,866	2,215	2,382	2,580	2,777
Gun Barrel City	704	977	1,104	1,243	1,411	1,632
Fort Worth	173,064	214,926	258,772	313,677	384,126	471,992
Aledo	0	456	1,031	1,605	1,712	1,712
Bethesda WSC	3,483	2,978	3,666	4,428	5,357	6,533
Burleson	5,248	7,676	9,462	9,550	9,749	10,062
Crowley	1,238	1,548	2,049	2,881	3,547	3,893
Dalworthington Gardens	505	550	581	596	608	618
Denton County-Other	445	579	663	743	825	908
Edgecliff	460	451	443	434	428	428
Everman	239	266	244	222	215	215
Forest Hill	1,492	1,584	1,671	1,776	1,912	2,008
Grand Prairie (through Fort	1,121	1,121	1,121	1,121	1,121	1,121
Haltom City	6,521	7,835	8,142	8,231	8,272	8,324
Haslet	663	1,434	2,576	2,568	2,561	2,561
Hurst	6,708	6,991	6,854	6,716	6,670	6,670
Keller	9,124	10,138	11,495	11,380	11,380	11,380
Kennedale	86	425	587	698	768	823
Lake Worth	585	665	757	845	945	999
North Richland Hills	3,516	3,917	4,193	4,357	4,475	4,574
Watauga	3,437	3,532	3,500	3,416	3,388	3,388
Northlake	268	404	467	898	1,329	1,599
Richland Hills	865	919	979	1,049	1,096	1,118
Roanoke	1,498	2,474	3,280	4,090	5,529	6,755
Saginaw	3,161	3,755	4,176	4,489	4,705	4,885
Sansom Park Village	51	57	57	53	56	63
Southlake (Tarrant & Denton Co)	9,321	9,826	9,949	10,514	11,259	11,855
Tarrant County Other	1,885	1,805	1,751	1,671	1,644	1,644
Trophy Club	2,077	2,420	2,707	2,962	3,249	3,536
Westover Hills	276	274	272	270	268	268
Westworth Village	350	412	426	442	470	519
White Settlement	1,524	1,640	1,735	1,824	2,024	2,246
Gun Barrel City		652	736	828	941	1,088
Kemp	224	267	307	300	296	296
Mabank (Henderson & Kaufman	671	801	931	1,083	1,269	1,507
Gun Barrel City	704	652	736	828	941	1,088
Malakoff	174	180	186	191	202	217
Mansfield	13,632	19,020	24,481	29,385	33,043	36,701
Grand Prairie (through Mansfield)	0	6,726	6,726	6,726	6,726	6,726
Johnson County SUD (through Mansfield)	1,682	3,363	6,726	6,726	6,726	6,726
Reno (thru Springtown & Walnut Creek SUD)	152	154	155	154	160	170
River Oaks	1,010	986	954	931	923	923
Runaway Bay	296	356	430	489	547	608
Springtown	268	423	571	725	877	1,036
Trinity River Authority						
Bedford	9,029	9,338	9,556	9,699	9,908	10,137
Colleyville	7,324	8,391	8,328	8,297	8,265	8,265
Ennis Total	***5,467***	***6,403***	***7,596***	***3,922***	***3,891***	***5,439***
Ferris	174	220	268	328	403	473
Grapevine	9,551	10,717	12,167	12,344	12,503	12,666
Euless	8,314	9,376	9,774	9,924	9,993	10,064
North Richland Hills	8,747	9,682	10,327	10,710	10,985	11,215
Midlothian Total	***1,020***	***10,882***	***13,512***	***15,701***	***17,923***	***20,033***
Venus (Region G)	363	358	349	344	342	342
Rockett SUD Total	***3,910***	***4,974***	***6,503***	***7,754***	***8,418***	***8,549***
Waxahachie Total	***2,500***	***2,660***	***4,830***	***10,344***	***16,627***	***22,299***
Walnut Creek SUD	2,606	3,794	5,895	7,222	7,631	7,922
Boyd	65	128	189	247	309	309
Rhome	347	712	1298	1908	2517	3126
New Fairview	0	51	119	188	267	358
Newark	0	63	132	249	395	618
Paradise	73	89	109	134	165	202
Sanctuary	92	216	314	370	426	478
Weatherford	2,542	3,694	4,727	5,717	6,768	7,991

	2011 Revised Demand Applied to TRWD					
WUGs	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Hudson Oaks	113	194	295	393	490	586
Parker County Other	0	228	230	227	213	200
Parker County SEP	24	22	28	56	75	102
West Cedar Creek MUD	1,724	2,604	3,335	4,002	4,860	5,933
Seven Points	188	222	254	288	330	385
Tool	405	452	500	548	610	695
West Wise Rural WSC	483	524	567	618	681	756
Chico	84	111	152	209	281	371
Freestone County Other (part)	285	344	388	400	400	400
Henderson County-Other	79	77	76	74	74	74
Kaufman County-Other	416	413	410	407	404	404
Navarro County-Other	100	98	96	93	92	92
Wise County-Other	1,888	2,130	2,110	2,071	2,051	2,051
Freestone County Steam Electric	6,726	7,726	7,726	7,726	7,726	7,726
Henderson County SEP	0	0	3,950	4,950	5,950	6,950
Henderson County Mining	79	91	98	106	113	120
Jack County-SEP	2,162	2,500	2,700	2,900	3,100	3,300
Kaufman County Irrigation	100	100	100	100	100	100
50% of Navarro County	586	664	734	803	865	936
Parker County Manufacturing	623	703	779	854	920	998
Tarrant County Manufacturing	17,258	20,444	23,630	26,924	29,919	32,457
Tarrant County Mining	536	452	469	487	504	518
Tarrant County Irrigation	5,518	4,208	4,208	4,208	4,208	4,208
Tarrant County Steam Electric	2,640	2,448	2,640	2,640	2,640	2,640
Wise County Irrigation	212	212	212	212	212	212
Wise County Manufacturing	2,299	2,646	2,965	3,263	3,525	3,844
Wise County Steam Electric Power	1,751	1,245	1,216	1,878	2,042	2,748
Wise County Mining	7,943	8,677	9,486	10,318	11,177	11,987
Subtotal - Existing	**459,585**	**576,461**	**671,684**	**763,086**	**869,304**	**994,702**
Potential Future Customers						
Alvord (through West Wise WSC)	0	150	150	150	150	150
Alvarado (Region G)	0	444	484	521	580	658
Annetta (through Weatherford)	0	25	65	99	134	176
Annetta South (through	0	5	16	24	35	47
Aurora (through Rhome through	0	50	50	50	50	86
Bardwell	0	17	42	69	100	135
Total, Corsicana and Customers	***0***	***0***	***1,628***	***2,547***	***3,702***	***5,172***
Fairfield	0	0	0	6	169	296
Mountain Peak SUD (through	155	586	658	856	1,224	1,701
Pantego	0	200	200	200	200	200
Pelican Bay	0	36	90	112	142	181
Sardis-Lone Elm WSC	0	2,155	2,934	2,890	2,867	2,867
Willow Park	0	177	541	800	974	1,098
Subtotal - Potential	**155**	**3,845**	**6,858**	**8,324**	**10,327**	**12,767**
TOTAL	**459,740**	**580,306**	**678,542**	**771,410**	**879,631**	**1,007,469**

PROJECT BUDGET - Entity Name - Tarrant Regional Water District (City of Dallas)						
Uses	**TWDB Funds Series 1**	**TWDB Funds Series 2**	**TWDB Funds Series 3**	**Total TWDB Cost**	**Other Funds**	**Total Cost**
Construction						
Construction	$94,490,000	$0	$0	$94,490,000	$13,030,000	$107,520,000
Subtotal Construction	**$94,490,000**	**$0**	**$0**	**$94,490,000**	**$13,030,000**	**$107,520,000**
Basic Engineering Fees						
Planning +	$0	$0	$0	$0	$0	$0
Design	$720,000	$0	$0	$720,000	$8,100,000	$8,820,000
Construction Engineering	$1,680,000	$0	$0	$1,680,000	$6,750,000	$8,430,000
Basic Engineering Other **_____	$0	$0	$0	$0	$0	$0
Subtotal Basic Engineering Fees	**$2,400,000**	**$0**	**$0**	**$2,400,000**	**$14,850,000**	**$17,250,000**
Special Services						
Application	$0	$0	$0	$0	$0	$0
Environmental	$0	$0	$0	$0	$0	$0
Water Conservation Plan	$0	$0	$0	$0	$0	$0
I/I Studies/Sewer Evaluation	$0	$0	$0	$0	$0	$0
Surveying	$1,310,000	$0	$0	$1,310,000	$0	$1,310,000
Geotechnical	$0	$0	$0	$0	$0	$0
Testing	$740,000	$0	$0	$740,000	$590,000	$1,330,000
Permits	$0	$0	$0	$0	$0	$0
Inspection	$0	$0	$0	$0	$0	$0
O&M Manual	$0	$0	$0	$0	$0	$0
Project Management (by engineer)	$7,940,000	$0	$0	$7,940,000	$2,240,000	$10,180,000
Pilot Testing	$0	$0	$0	$0	$0	$0
Water Distribution Modeling	$0	$0	$0	$0	$0	$0
Special Services Other **_____	$0	$0	$0	$0	$0	$0
Subtotal Special Services	**$9,990,000**	**$0**	**$0**	**$9,990,000**	**$2,830,000**	**$12,820,000**
Other						
Administration	$10,850,000	$0	$0	$10,850,000	$12,110,000	$22,960,000
Land/Easements Acquisition	$12,770,000	$0	$0	$12,770,000	$12,030,000	$24,800,000
Water Rights Purchase (If Applicable)	$0	$0	$0	$0	$0	$0
Capacity Buy-In (If Applicable)	$0	$0	$0	$0	$0	$0
Project Legal Expenses	$0	$0	$0	$0	$0	$0
Other **	$0	$0	$0	$0	$0	$0
Subtotal Other Services	**$23,620,000**	**$0**	**$0**	**$23,620,000**	**$24,140,000**	**$47,760,000**
Fiscal Services						
Financial Advisor	$0	$0	$0	$0	$0	$0
Bond Counsel	$0	$0	$0	$0	$0	$0
Issuance Cost	$420,000	$0	$0	$420,000	$310,000	$730,000
Bond Insurance/Surety	$0	$0	$0	$0	$0	$0
Fiscal/Legal	$0	$0	$0	$0	$0	$0
Capitalized Interest	$0	$0	$0	$0	$0	$0
Bond Reserve Fund	$8,170,000	$0	$0	$8,170,000	$6,970,000	$15,140,000
Loan Origination Fee	$0	$0	$0	$0	$0	$0
Other **	$0	$0	$0	$0	$0	$0
Subtotal Fiscal Services	**$8,590,000**	**$0**	**$0**	**$8,590,000**	**$7,280,000**	**$15,870,000**
Contingency						
Contingency	$910,000	$0	$0	$910,000	$4,870,000	$5,780,000
Subtotal Contingency	**$910,000**	**$0**	**$0**	**$910,000**	**$4,870,000**	**$5,780,000**
TOTAL COSTS	**$140,000,000**	**$0**	**$0**	**$140,000,000**	**$67,000,000**	**$207,000,000**

Other ** description must be entered

+ For Planning applications under the EDAP Program, please break down Planning costs as follows:

Category A			0
Category B			0
Category C			0
Category D			0
Total Planning Costs	0	0	0

PROJECT BUDGET - Entity Name - Tarrant Regional Water District - TRWD Bond						
Uses	**TWDB Funds Series 1**	**TWDB Funds Series 2**	**TWDB Funds Series 3**	**Total TWDB Cost**	**Other Funds**	**Total Cost**
Construction						
Construction	$217,630,000	$0	$0	$217,630,000	$123,270,000	$340,900,000
Subtotal Construction	**$217,630,000**	**$0**	**$0**	**$217,630,000**	**$123,270,000**	**$340,900,000**
Basic Engineering Fees						
Planning +	$0	$0	$0	$0	$0	$0
Design	$1,250,000	$0	$0	$1,250,000	$0	$1,250,000
Construction Engineering	$4,540,000	$0	$0	$4,540,000	$3,970,000	$8,510,000
Basic Engineering Other ** _____	$0	$0	$0	$0	$0	$0
Subtotal Basic Engineering Fees	**$5,790,000**	**$0**	**$0**	**$5,790,000**	**$3,970,000**	**$9,760,000**
Special Services						
Application	$0	$0	$0	$0	$0	$0
Environmental	$0	$0	$0	$0	$0	$0
Water Conservation Plan	$0	$0	$0	$0	$0	$0
I/I Studies/Sewer Evaluation	$0	$0	$0	$0	$0	$0
Surveying	$1,430,000	$0	$0	$1,430,000	$0	$1,430,000
Geotechnical	$0	$0	$0	$0	$0	$0
Testing	$2,090,000	$0	$0	$2,090,000	$1,800,000	$3,890,000
Permits	$0	$0	$0	$0	$0	$0
Inspection	$0	$0	$0	$0	$0	$0
O&M Manual	$0	$0	$0	$0	$0	$0
Project Management (by engineer)	$14,910,000	$0	$0	$14,910,000	$6,700,000	$21,610,000
Pilot Testing	$0	$0	$0	$0	$0	$0
Water Distribution Modeling	$0	$0	$0	$0	$0	$0
Special Services Other ** _____	$0	$0	$0	$0	$0	$0
Subtotal Special Services	**$18,430,000**	**$0**	**$0**	**$18,430,000**	**$8,500,000**	**$26,930,000**
Other						
Administration	$15,960,000	$0	$0	$15,960,000	$16,300,000	$32,260,000
Land/Easements Acquisition	$24,660,000	$0	$0	$24,660,000	$17,970,000	$42,630,000
Water Rights Purchase (If Applicable)	$0	$0	$0	$0	$0	$0
Capacity Buy-In (If Applicable)	$0	$0	$0	$0	$0	$0
Project Legal Expenses	$0	$0	$0	$0	$0	$0
Other **	$0	$0	$0	$0	$0	$0
Subtotal Other Services	**$40,620,000**	**$0**	**$0**	**$40,620,000**	**$34,270,000**	**$74,890,000**
Fiscal Services						
Financial Advisor	$0	$0	$0	$0	$0	$0
Bond Counsel	$0	$0	$0	$0	$0	$0
Issuance Cost	$790,000	$0	$0	$790,000	$650,000	$1,440,000
Bond Insurance/Surety	$0	$0	$0	$0	$0	$0
Fiscal/Legal	$0	$0	$0	$0	$0	$0
Capitalized Interest	$0	$0	$0	$0	$0	$0
Bond Reserve Fund	$15,120,000	$0	$0	$15,120,000	$14,380,000	$29,500,000
Loan Origination Fee	$0	$0	$0	$0	$0	$0
Other **	$0	$0	$0	$0	$0	$0
Subtotal Fiscal Services	**$15,910,000**	**$0**	**$0**	**$15,910,000**	**$15,030,000**	**$30,940,000**
Contingency						
Contingency	$1,620,000	$0	$0	$1,620,000	$9,660,000	$11,280,000
Subtotal Contingency	**$1,620,000**	**$0**	**$0**	**$1,620,000**	**$9,660,000**	**$11,280,000**
TOTAL COSTS	**$300,000,000**	**$0**	**$0**	**$300,000,000**	**$194,700,000**	**$494,700,000**

Other ** description must be entered

+ For Planning applications under the EDAP Program, please break down Planning costs as follows:

Category A			0
Category B			0
Category C			0
Category D			0
Total Planning Costs	0	0	0

Texas Water Development Board
Water Project Information

A. Project Name	B. Project No.	C. County	D. Regional Planning Group (A-P)
Integrated Pipeline Project		Tarrant, Johnson, Ellis, Henderson, Navarro	C
E. Program(s)	F. Loan ■ / Grant ☐ Amount:	G. Loan Term:	
SWIFT	$440,000,000	30 year	

H. Water Project Description: (Multiphase project, new or expansion; plant, well, storage, pump station, distribution system, etc)

TRWD and DWU have partnered to finance, plan, design construct and operate the Integrated Pipeline (IPL) Project. The IPL Project is an integrated water delivery transmission system connecting Lake Palestine to Lake Benbrook with connections to Cedar Creek and Richland-Chambers Reservoirs integrating TRWD•s existing pipelines and creating flexibility in delivery as well as quick response to fluctuating customer water demands. The IPL Project consists of 150 miles of pipeline, three new lake pump stations, and three new booster pump stations delivering a required capacity of 350 million gallons per day (MGD) of raw water to North Central Texas.

Attach map of service area affected by Project or other documentation.

I. Is an Inter Basin Transfer potentially involved?	J. Is project located in a Groundwater District (If yes, identify District by name)?
Yes ■ No ☐	Yes ■ Neches and Trinity Valley GCD, Prairielands GCD and Northern Trinity GCD No ☐

K. Projected Population from application for at least a 20 year period. Attach justification and list service area populations if different from Planning Area.	Year	Reference Year	2010	2020	2030	2040	2060
	Population Projection	2010	4,108,696	5,223,050,	5,885,408	6,584,423	8,511,549

Project Design Year	2060	Design Population	8,511,549

L. Is the proposed project included in a current Regional Water Plan? Yes ■ No ☐ Don't Know ☐
(If Yes, please specify on what page in the Regional Water Plan - Regional Water Plan Page Number: P 4E.18 Table 4E.3; P.4E.14 Table 4E.3

M. What type of water source is associated directly with the proposed project? Surface Water ■ Groundwater ☐ Reuse ☐

N. Will the project increase the volume of water supply? Yes ■ No ☐

O. What volume of water is the project anticipated to deliver/ treat per year? 392,077.07 Acre-Feet/Year

P. Current Water Supply Information

Surface Water Supply Source / Provider Names	Certificate No.	Source County	Annual Volume and Unit
			263,059 acre ft/yr 310,465 acre ft/yr
Groundwater Source Aquifer	**Well Field location**	**Source County**	**Annual Volume and Unit**

Q. Proposed Water Supply Associated Directly with the Proposed Project

Surface Water Supply Source / Provider Names	Certificate No.	Source County	Annual Volume and Unit
		Henderson, Navarro/Freestone	263,059 acre ft/yr 310,465 acre ft/yr
Groundwater Source Aquifer	**Well Field location:**	**Source County**	**Annual Volume and Unit**

R. Consulting Engineer Name	Telephone No.	E-mail address
	817-720-4255	ed.weaver@trwd.com
S. Applicant Contact Name, Title	Telephone No.	E-mail address
	817-720-4364	sandy.newby@trwd.com

Integrated Pipeline Program
Current Construction Schedule
TWDB

PL 10/PL 11
Start: 3/1/2016
End: 2/28/2018

DWU
Start: 1/1/2016
End: 6/1/2017

PL 9
Start: 1/3/2033
End: 7/5/2035

PL 12/PL 13/MBR
Start: 11/10/2014
End: 4/7/2017

JB4
Start: 7/1/2031
End: 7/3/2035

JB4 Bypass
Start: 3/1/2016
End: 2/28/2018

Existing TRWD Pipelines

JB3
Start: 7/21/2014
End: 2/13/2018

PL 14
Start: 1/1/2016
End: 10/31/2017

PL 17/PL 18
Start: 3/1/2016
End: 11/30/2020

JCC1 Intake
Start: 12/1/2016
End: 5/31/2019

JCC1 PS
Start: 11/29/2018
End: 6/01/2021

PL 19-1
Start: 7/1/2020
End: 12/28/2022

PL 15-2
Start: 7/16/2015
End: 7/19/2017

PL 15-1
Start: 5/1/2014
End: 8/6/2015

JB2
Start: 7/1/2026
End: 7/3/2030

PL 19-2
Start: 1/2/2022
End: 7/3/2024

PL 16
Start: 9/1/2028
End: 3/10/2031

JRC1
Start: 7/1/2028
End: 7/3/2032

LP1 Intake
Start: 7/1/2020
End: 12/29/2022

LP1 PS
Start: 7/3/2022
End: 12/31/2024

Includes Land Cost for IPL Section 9, 16, 19-2 and 19-1

Projected Population for Customers of Dallas

WUGs	2011 Population Revisions Applied to DWU					
	2010	2020	2030	2040	2050	2060
Addison	16,000	20,534	22,358	23,629	24,515	25,133
Carrollton	121,000	124,000	128,500	131,320	133,450	134,800
Hebron	500	500	500	500	500	500
Cedar Hill	45,006	65,460	76,836	80,316	80,316	80,316
Cockrell Hill	4,782	4,947	5,028	5,067	5,086	5,095
Coppell	40,415	40,577	40,715	40,832	40,932	41,016
Dallas	1,312,324	1,415,000	1,495,000	1,598,223	1,764,681	2,058,767
Balch Springs	21,083	22,564	23,849	24,963	25,930	26,768
Dallas County - Other	737	572	444	339	267	201
Denton	0	0	34,265	89,385	156,342	288,625
DeSoto	47,649	57,243	65,849	73,881	82,923	85,400
Duncanville	37,100	37,100	37,100	37,100	37,100	37,100
Farmers Branch	30,470	33,161	35,608	37,833	39,855	41,693
Flower Mound	33,334	34,000	35,712	35,712	35,712	35,712
Glenn Heights	11,423	13,833	16,516	19,102	21,705	24,332
Oak Leaf	1,257	1,526	1,791	2,064	2,368	2,705
Grand Prairie	138,890	79,184	109,037	135,988	164,725	164,725
Grapevine	11,503	10,725	10,680	9,600	8,820	8,220
Hutchins	3,200	4,000	5,000	6,500	8,500	14,000
Wilmer	1,037	1,712	2,465	4,740	11,242	19,228
Irving	59,413	67,228	14,584	14,459	14,390	14,460
Lancaster	37,392	59,067	64,648	64,648	64,648	64,648
Lewisville	97,709	110,002	122,002	136,002	155,002	176,515
Denton County FWSD NO. 1A	309	1,634	2,211	2,805	3,408	4,039
Ovilla	3,634	5,851	8,066	10,287	10,829	11,621
Red Oak	10,000	17,850	23,400	26,600	28,500	30,400
Seagoville	13,017	16,327	19,537	22,848	25,536	27,517
Combine WSC	4,122	5,737	7,202	8,795	10,785	13,285
Combine	2,393	2,969	3,474	4,019	4,702	5,563
The Colony	36,450	50,400	56,700	58,500	60,300	60,840
UTRWD	72,061	287,544	322,273	331,711	339,917	346,339
UTRWD Add'l						63,290
Total	**2,214,210**	**2,591,247**	**2,791,350**	**3,037,768**	**3,362,986**	**3,912,853**

Projected Population for Customers of Tarrant Regional Water District

WUGs	2011 Population Revisions Applied to TRWD					
	2010	2020	2030	2040	2050	2060
Arlington	331,146	373,575	398,700	421,082	421,554	422,498
Grand Prairie (through Arlington)	0	44,799	44,799	44,799	44,799	44,799
Bethesda WSC	0	10,551	13,196	16,069	19,598	23,900
Azle	12,108	16,795	23,473	31,060	38,682	45,362
Benbrook	18,912	27,000	30,000	36,000	43,000	51,000
Blue Mound	0	0	0	0	0	0
Bridgeport	5,900	8,352	12,001	14,296	16,657	19,936
Community WSC	3,536	3,588	3,642	3,699	3,767	3,847
Decatur	6,804	8,508	11,738	15,253	19,751	23,225
East Cedar Creek FWSD	9,973	11,178	13,363	14,568	15,773	16,978
Gun Barrel City	3,066	4,321	4,954	5,603	6,395	7,394
Fort Worth	732,201	926,822	1,127,326	1,379,008	1,696,962	2,085,879
Aledo	0	2,675	6,138	9,616	10,262	10,262
Bethesda WSC	24,111	21,117	26,383	32,129	39,172	47,768
Burleson	32,091	48,255	60,336	61,782	63,517	65,567
Crowley	8,190	10,549	14,181	20,246	25,128	27,589
Dalworthington Gardens	1,616	1,786	1,901	1,969	2,020	2,052
Denton County-Other	2,137	2,822	3,271	3,686	4,090	4,506
Edgecliff	2,550	2,550	2,550	2,550	2,550	2,550
Everman	1,922	2,198	2,072	1,940	1,901	1,901
Forest Hill	12,000	13,090	14,210	15,392	16,738	17,574
Grand Prairie	6,460	89,180	90,787	91,265	90,642	90,642
Haltom City	41,000	50,322	53,058	54,428	55,113	55,456
Haslet	1,692	3,688	6,685	6,685	6,685	6,685
Hurst	34,635	36,695	36,654	36,572	36,531	36,531
Keller	40,127	45,026	51,310	51,310	51,310	51,310
Kennedale	483	2,420	3,378	4,048	4,476	4,802
Lake Worth	3,053	3,553	4,122	4,686	5,278	5,573
North Richland Hills	18,226	20,801	22,533	23,737	24,496	25,009
Watauga	23,423	24,632	25,000	25,000	25,000	25,000
Northlake	1,700	2,487	2,877	5,530	8,182	9,842
Richland Hills	5,477	5,985	6,518	7,148	7,522	7,682
Roanoke	5,971	9,132	12,199	15,282	20,642	25,228
Saginaw	18,813	22,803	25,711	27,829	29,373	30,499
Sansom Park Village	372	426	437	417	442	495
Southlake (Tarrant & Denton Co)	28,019	29,636	30,107	31,924	34,188	36,000
Tarrant County-Other	12,936	12,697	12,505	12,219	12,123	12,123
Trophy Club	6,025	7,064	7,954	8,730	9,568	10,416
Westover Hills	658	658	658	658	658	658
Westworth Village	3,224	3,403	3,618	3,869	4,156	4,586
White Settlement	9,512	10,540	11,394	12,236	13,694	15,180
Kemp	1,400	1,700	2,000	2,000	2,000	2,000
Mabank (Henderson & Kaufman Co.)	3,074	3,729	4,401	5,142	6,058	7,194
GBC (added by LPB)	3,065	2,880	3,302	3,735	4,263	4,930
Malakoff	1,195	1,265	1,339	1,409	1,502	1,614
Mansfield	57,337	87,375	108,258	123,658	139,058	154,458
Johnson County SUD	8,791	17,242	33,744	32,640	31,639	31,628
Grand Prairie	0	67,198	79,202	89,146	99,604	99,604
River Oaks	7,100	7,100	7,100	7,100	7,100	7,100
Runaway Bay	1,411	1,720	2,097	2,400	2,700	3,000
Springtown	1,596	2,568	3,540	4,524	5,516	6,512
Reno	1,223	1,284	1,329	1,362	1,427	1,515
Trinity River Authority	0	0	0	0	0	0
Bedford	44,551	46,841	48,749	50,320	51,710	52,900
Buena Vista Bethel SUD	2,901	4,089	5,487	7,075	8,811	10,701
Ennis (by 2030)	103	105	101	2,154	15,827	23,226
Community Water Company (Ellis County)	0	1,414	1,690	1,972	2,288	0
Rice WSC	0	417	421	429	429	0
Ellis County-Other (by 2020)	0	299	303	305	31	0
Ferris (by 2020)	1,142	1,476	1,839	2,305	2,880	3,380
Palmer (by 2020)	0	0	0	0	0	0
Italy (by 2020)	0	356	638	953	1,329	1,768
Euless	45,803	52,622	55,936	57,553	58,287	58,715
North Richland Hills	45,403	51,452	55,539	58,300	60,166	61,426
Maypearl (by 2020)	0	0	0	0	0	0
Midlothian	0	13,368	26,851	38,932	51,987	65,131
Grand Prairie	0	72,803	85,808	96,581	107,912	107,912
Venus (Region G)	2,435	2,435	2,435	2,435	2,435	2,435
Rockett SUD	21,073	29,038	41,003	50,936	56,255	56,890
Oak Leaf	245	248	251	252	254	255
Lancaster	608	597	653	653	653	653
Red Oak	625	1,050	1,300	1,400	1,500	1,600
Pecan Hill	813	943	1,072	1,203	1,350	1,512
Waxahachie	30,000	39,000	46,342	59,322	75,937	97,206
Colleyville	22,099	25,564	25,536	25,536	25,536	25,536

WUGs	2011 Population Revisions Applied to TRWD					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
Grapevine	28,398	32,230	36,840	37,620	38,220	38,700
Walnut Creek SUD	21,343	31,654	50,123	62,000	65,500	68,000
Boyd	453	920	1,395	1,866	2,356	2,356
Rhome	953	1,969	3,621	5,322	7,022	8,723
New Fairview	0	407	956	1,513	2,145	2,876
Newark	0	482	1,027	1,968	3,121	4,880
Paradise	563	691	848	1,041	1,278	1,568
Sanctuary	715	1,675	2,435	2,875	3,305	3,708
Weatherford	12,390	18,414	23,825	28,984	34,531	40,770
Hudson Oaks (starting by 2010)	574	995	1,522	2,041	2,544	3,042
Parker County Other	0	1,867	1,915	1,933	1,825	1,715
West Cedar Creek MUD	17,100	22,567	28,089	34,021	41,323	50,443
Seven Points	1,402	1,681	1,956	2,238	2,582	3,016
Tool	2,618	2,990	3,357	3,733	4,192	4,771
West Wise Rural WSC	3,474	3,864	4,287	4,758	5,283	5,865
Chico	525	708	992	1,382	1,874	2,472
Freestone County Other	9,298	9,717	9,935	9,998	9,998	9,998
Henderson County-Other	401	398	398	395	399	399
Kaufman County-Other	2,753	2,753	2,753	2,753	2,753	2,753
Navarro County-Other	704	708	708	702	708	708
Wise County-Other	15,901	17,609	17,609	17,609	17,609	17,609
Subtotal - Existing	**1,893,627**	**2,614,156**	**3,064,595**	**3,510,804**	**4,007,407**	**4,543,477**
Potential Future Customers						
Annetta (through Weatherford)	0	185.368	487.557	748.688	1022.448	1343.448
Annetta South (through Weatherford)	0	40.128	129.582	199.432	290.857	392.64
Aurora (through Rhome through Walnut Creek SUD)	0	412.2	422	425.502	428.697	737.87
Bardwell	0	140.825	354.468	585.934	850.297	1146.208
Corsicana	0	0	4073.93384	6843.886067	10602.39923	15786.30941
Fairfield	0	0	0	30.5	800.4	1395
Files Valley SUD	0	986.3354037	992.3652695	1002.322206	1000.973574	993.5185185
Mountain Peak SUD	859.248	3296.246	3723.237	4901.607	7012.28	9741.187
Pantego	0	669.902	676.856	676.856	690.764	690.764
Pelican Bay	0	344.4	765.072	970.79	1243.644	1582.056
Sardis-Lone Elm WSC	0	10455.472	14385.848	14325.74	14305.704	14305.704
Willow Park	0	1115.49	3451.926	5140	6305.6	7104
Subtotal - Potential	859.248	17646.3664	29462.84511	35851.25727	44554.06381	55218.70493
TOTAL	**1,894,486**	**2,631,803**	**3,094,058**	**3,546,655**	**4,051,961**	**4,598,696**

CERTIFICATE OF ADJUDICATION

CERTIFICATE OF ADJUDICATION: 08-4976

OWNER: Tarrant County Water Control and Improvement District No. 1
P. O. Box 4508
Fort Worth, Texas 76106

COUNTIES: Henderson and Kaufman

PRIORITY DATE: May 28, 1956

WATERCOURSE: Cedar Creek, tributary of the Trinity River

BASIN: Trinity River

WHEREAS, by final decree of the 66th Judicial District Court of Hill County, in Cause No. 28,952 In Re: The Adjudication of Water Rights in the Middle Trinity River Segment of the Trinity River Basin dated September 4, 1986 a right was recognized under Permit 1909 authorizing the Tarrant County Water Control and Improvement District No. 1 to appropriate waters of the State of Texas as set forth below;

NOW, THEREFORE, this certificate of adjudication to appropriate waters of the State of Texas in the Trinity River Basin is isaued to the Tarrant County Water Control and Improvement District No. 1, subject to the following terms and conditions:

1. IMPOUNDMENT

Owner is authorized to maintain an existing dam and reaervoir on Cedar Creek (Cedar Creek Reservoir) and impound therein not to exceed 678,900 acre-feet of water. The dam is located in the Jonathan Ping Survey, Abstract 608 and the M. M. Sanola Survey, Abstract 697, Henderson County, Texas.

2. USE

A. Owner ia authorized to divert and use not to exceed 175,000 acre-feet of water per annum from Cedar Creek (Cedar Creek Reservoir) for municipal and industrial purposes.

B. Owner is authorized to use the water impounded in the reservoir for recreation purposes.

3. DIVERSION

A. Location

(1) At five pointa on the perimeter of Cedar Creek Reservoir in the M. M. Sanchez Survey, Abstract 697; the James Smith Survey, Abstract 742; the J. P. Brown Survey, Abstract 59 and the John Baker Survey, Abstract 1203, Henderson County, Texas.

(2) At one point on the perimeter of Cedar Creek Reservoir in the Ezekiel Higdon Survey, Abstract 197, Kaufman County, Texas.

B. Maximum combined rate: 247.54 cfs (111,393 gpm).

4. PRIORITY

The time priority of owner's right is May 28, 1956.

5. SPECIAL CONDITIONS

A. Owner shall maintain a suitable outlet in the aforessid dam authorized herein to allow the free passage of water that owner is not entitled to divert or impound.

B. Owner may transport the water authorized herein from Cedar Creek Reservoir to places of use in Tarrant, Navarro and Ellis Counties, or those portions of Henderson, Kaufman, Van Zandt and Johnson Counties within the Trinity River Watershed and is expressly granted the right to enter into contracts for the use of such water with cities, municipalities, industries, and other users of water.

The locations of pertinent features related to this certificate are shown on Pages 4, 8 and 9 of the Middle Trinity River Segment Certificates of Adjudication Maps, copies of which are located in the office of the Texas Water Commission, Austin, Texas.

This certificate of adjudication is issued subject to all terms, conditions and provisions in the final decree of the 66th Judicial District Court of Hill County, Texas, in Cause No. 28,952 In Re: The Adjudication of Water Rights in the Middle Trinity River Segment of the Trinity River Basin dated September 4, 1986 and supersedes all rights of the owner ssserted in that cause.

This certificate of adjudication is issued subject to senior and superior water rights in the Trinity River Basin.

This certificate of adjudication is issued subject to the Rules of the Texas Water Commission and its continuing right of supervision of State water resources consistent with the public policy of the State as set forth in the Texas Water Code.

TEXAS WATER COMMISSION

/s/ Paul Hopkins
Paul Hopkins, Chairman

DATE ISSUED:

MAY 05 1987

ATTEST:

/s/ Mary Ann Hefner
Mary Ann Hefner, Chief Clerk

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

THE STATE OF TEXAS
COUNTY OF TRAVIS
I hereby certify that this is a [illegible]
Texas Commission on Environmental [illegible]
which is filed in the permanent [illegible]
Given under my hand and the [illegible]

Bridget C. Bohac

Bridget C Bohac, Chief Clerk
Texas Commission on Environmental Quality

AMENDMENT TO CERTIFICATE OF ADJUDICATION

CERTIFICATE NO. 08-4976D

TYPE: §§11.122

Owner:	Tarrant Regional Water District	Address:	P.O. Box 4508 Fort Worth, Texas 76164
Filed:	October 29, 2013	Granted:	November 25, 2014
Purposes:	Municipal, Mining, Industrial and Agricultural	Counties:	Henderson and Kaufman
Watercourse:	Cedar Creek, tributary of the Trinity River	Watershed:	Trinity River Basin

WHEREAS, Certificate of Adjudication No. 08-4976 authorizes Tarrant Regional Water District (TRWD or Owner) to maintain an existing dam and reservoir on Cedar Creek (Cedar Creek Reservoir), tributary of the Trinity River, Trinity River Basin and impound not to exceed 678,900 acre-feet of water for recreational purposes; and

WHEREAS, Owner is also authorized to divert not to exceed 90,799 acre-feet of District Return Flows per year from the Trinity River at a maximum rate of 156.5 cfs (70,300 gpm) into an off-channel wetland impoundment with a storage capacity of 2,700 acre-feet for water quality treatment purposes and to subsequently divert and store 88,059 acre-feet of those District Return Flows per year in Cedar Creek Reservoir; and

WHEREAS, TRWD is also authorized to divert and use not to exceed 227,500 acre-feet of water per year from six points on the perimeter of Cedar Creek Reservoir for municipal, mining, industrial and agricultural purposes within TRWD's service area in the Trinity River Basin with not to exceed 52,500 acre-feet of water per year diverted being accounted for as District Return Flows diverted from the Trinity River; and

WHEREAS, multiple diversion rates, priority dates and special conditions apply; and

WHEREAS, TRWD has applied for an amendment to Certificate of Adjudication No. 08-4976 to increase the amount of District Return Flows authorized for diversion from Cedar Creek Reservoir by an additional 35,559 acre-feet of water per year for a total of 88,059 acre-feet per year for municipal, mining, industrial and agricultural purposes within TRWD's service area in the Trinity River Basin; and

WHEREAS, TRWD does not request authorization to divert more water from the reservoir than they are currently authorized to discharge into Cedar Creek Reservoir from the wetlands; and

WHEREAS, the Texas Commission on Environmental Quality (TCEQ or Commission) finds that jurisdiction over the application is established; and

WHEREAS, the Executive Director recommends that special conditions be included in the amendment; and

WHEREAS, one request for a contested case hearing was received for this application and was subsequently withdrawn; and

WHEREAS, the Commission has complied with the requirements of the Texas Water Code and Rules of the Texas Commission on Environmental Quality in issuing this amendment;

NOW, THEREFORE, this amendment to Certificate of Adjudication No. 08-4976, designated Certificate of Adjudication No. 08-4976D, is issued to Tarrant Regional Water District subject to the following terms and conditions:

1. USE

In lieu of thc previous authorization in USE Paragraph 2.B., of Certificate of Adjudication No . 08-4976C to divert and use not to exceed 227,500 acre-feet of water per year from Cedar Creek Reservoir for municipal, mining, industrial and agricultural purposes within TRWD's service area in the Trinity River Basin with not to exceed 52,500 acre-feet of water per year diverted being accounted for as District Return Flows diverted from the Trinity River, Owner is now authorized divert and use not to excccd 263,059 acre-feet of water per year from Cedar Creek Reservoir for municipal, mining, industrial and agricultural purposes within TRWD's service area in the Trinity River Basin with not to exceed 88,059 acre-feet of water per year diverted being accounted for as District Return Flows diverted from the Trinity River.

2. DIVERSION

In addition to the previous authorizations, Owner is authorized to divert the additional 35,559 acre-feet of water per year at those points on Cedar Creek

Reservoir currently authorized by this Certificate.

3. SPECIAL CONDITIONS

a. Owner shall only divert and use water in accordance with the most recently approved *Accounting Plan for the Tarrant Regional Water District's Water Supply*. Owner shall maintain the plan in electronic format and make the data available to the Executive Director upon request. Any modifications to the accounting plan shall be approved by the Executive Director. Any modification to the accounting plan that changes the terms of the certificate must be in the form of an amendment to the certificate. Should Owner fail to maintain the accounting plan or notify the Executive Director of any modifications to the plan, Owner shall immediately cease diversion of water and either apply to amend the certificate, or voluntarily forfeit the amendment. If Owner fails to amend the accounting plan or forfeit the amendment, the Commission may begin proceedings to cancel the amendment. Owner shall immediately notify the Executive Director upon modification of the accounting plan and provide copies of the appropriate documents effectuating such changes.

b. Ninety (90) days prior to the diversion of water for industrial, mining, or agricultural purposes, Owner shall submit to the TCEQ a water conservation plan to comply with Title 30 TAC Chapter 288.

4. CONSERVATION

Owner shall implement water conservation plans that provide for the utilization of those practices, techniques, and technologies that reduce or maintain the consumption of water, prevent or reduce the loss or waste of water, maintain or improve the efficiency in the use of water, increase the recycling and reuse of water, or prevent the pollution of water, so that a water supply is made available for future or alternative uses. Such plans shall include a requirement that in every wholesale water contract entered into on or after the effective date of this amendment, including any contract extension or renewal, that each successive wholesale customer develop and implement conservation measures. If the customer intends to resell the water, then the contract for resale of the water must have water conservation requirements so that each successive wholesale customer in the resale of the water be required to implement water conservation measures.

This amendment is issued subject to all terms, conditions, and provisions contained in Certificate of Adjudication No. 08-4976, as amended, except as specifically amended herein.

This amendment is issued subject to all superior and senior water rights in the Trinity River Basin.

Owner agrees to be bound by the terms, conditions, and provisions contained herein and such agreement is a condition precedent to the granting of this amendment.

All other matters requested in the application which are not specifically granted by this amendment are denied.

This amendment is issued subject to the Rules of the Texas Commission on Environmental Quality and to the right of continuing supervision of State resources exercised by the Commission.

For the Commission

Date Issued: **November 25, 2014**

I, Mary Margaret Wright, County Clerk in and for Henderson County, Texas hereby Certify the above to be a true and correct copy as the same appeas in my office Vol OR Page 916
Record Date of issuance 1-15 2015
By Barbara Cox Deputy.

TRUE AND CORRECT COPY OF ORIGINAL FILED IN HENDERSON COUNTY CLERK'S OFFICE

VOL. 750 PAGE 228

2178

CERTIFICATE OF ADJUDICATION

CERTIFICATE OF ADJUDICATION: 08-5035

OWNER: Tarrant County Water Control and Improvement District No. 1
P. O. Box 4508
Fort Worth, Texas 76106

COUNTIES: Freestone and Navarro

PRIORITY DATE: October 18, 1954

WATERCOURSE: Richland Creek, tributary of the Trinity River

BASIN: Trinity River

WHEREAS, by final decree of the 66th Judicial District Court of Hill County, in Cause No. 28,952 In Re: The Adjudication of Water Rights in the Middle Trinity River Segment of the Trinity River Basin dated September 4, 1986 a right was recognized under Permit 3216 authorizing the Tarrant County Water Control and Improvement District No. 1 to appropriate waters of the State of Texas as set forth below;

NOW, THEREFORE, this certificate of adjudication to appropriate waters of the State of Texas in the Trinity River Basin is issued to the Tarrant County Water Control and Improvement District No. 1, subject to the following terms and conditions:

1. IMPOUNDMENT

Owner is authorized to maintain an existing dam and reservoir on Richland Creek (Richland Creek Reservoir) and impound therein not to exceed 1,135,000 acre-feet of water. The dam is located in the John Thomas Survey, Abstract 603; the Martha Boyd Survey, Abstract 96; the John A. Loyd Survey, Abstract 370; the Florinda Dixon Survey, Abstract 198; the William Lockridge Survey, Abstract 366 in Freestone County and the Garnett G. Cole Survey, Abstract 152 in Navarro County, Texas.

2. USE

Owner is authorized to divert and use not to exceed 210,000 acre-feet of water per annum from Richland Creek Reservoir for municipal purposes.

3. DIVERSION

A. Location
At a point on the perimeter of the aforesaid reservoir in the Julian Fontonoy Survey, Abstract 265, Navarro County, Texas.

B. Maximum rate: 577.78 cfs (260,000 gpm).

4. PRIORITY

The time priority of owner's right is October 18, 1954.

5. SPECIAL CONDITIONS

A. Owner shall maintain a suitable outlet in the aforesaid dam authorized herein to allow the free passage of water that owner is not entitled to divert or impound.

B. Owner shall install and maintain a continuous lake level measuring station for the authorized reservoir and maintain tbe following daily records: (1) Reservoir content; (2) Discharge past the dam; and (3) Diversion for each authorized use. All records shall be compiled monthly and reported to the Commission annually and at other times on request.

C. Owner shall survey and monument an appropriate number of sediment ranges prior to impoundment of water. A set of drawings showing the locations and a profile of each range will be submitted to the Commission along with a revised elevation-area-capacity table based on the surveyed ranges.

D. Fsilure to complete construction of the dam and related facilities within the time limitations established by the Commission shall cause this Certificate of Adjudication to expire and become null and void, unless owners apply for an extension of time to complete construction prior to the deadlines for completion, and the application is subsequently granted. If this certificate of adjudication expires, owner shall thereafter remove the dam in accordance with plans approved by tbe Commission.

E. Priority under this Certificate of Adjudication shall he junior in time to Certificate of Adjudication 08-4992 (October 4, 1959), previously Permit 1948B, (Navarro Mills Reservoir) and Certificate of Adjudication 08-5021 (July 30, 1956), previously Permit 2068, (Bardwell Reservoir).

The locations of pertinent features related to this certificate are shown on Page 20 of the Middle Trinity River Segment Certificates of Adjudication Maps, copies of which are located in the office of the Texas Water Commission, Austin, Texas.

This certificate of adjudication is issued subject to all terms, conditions and provisions in the final decree of the 66th Judicial District Court of Hill County, Texas, in Cause No. 28,952 In Re: The Adjudication of Water Rights in the Middle Trinity River Segment of the Trinity River Basin dated September 4, 1986 and supersedes all rights of the owner asserted in that cause.

Certificate of Adjudication 08-5035

This certificate of adjudication is issued subject to senior and superior water rights in the Trinity River Basin.

This certificate of adjudication is issued subject to the Rules of the Texas Water Commission and its continuing right of supervision of State water resources consistent with the public policy of the State as set forth in the Texas Water Code.

TEXAS WATER COMMISSION

Paul Hopkins

Paul Hopkins, Chairman

DATE ISSUED:

MAY 05 1987

ATTEST:

Mary Ann Hefner

Mary Ann Hefner, Chief Clerk

STATE OF TEXAS
COUNTY OF TRAVIS

I, Mary Ann Hefner, Chief Clerk of the Texas Water Commission, do hereby certify that the foregoing is a true and correct copy of an instrument on file in permanent records of said Commission

Given under my hand and the seal of the Texas Water Commission this the 5th day of May A. D., 1987.

Mary Ann Hefner

Mary Ann Hefner, Chief Clerk

FILED FOR RECORD
At 9:00, o'clock a. M.

MAY 8 1987

DORIS TERRY WELCH
Clerk County Court, Freestone County, Texas
By Doris Terry Welch

01404164

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

THE STATE OF TEXAS
COUNTY OF TRAVIS
I hereby certify that this is a true and correct copy of a Texas Commission on Environmental Quality document which is filed in the permanent records of the Commission
Given under my hand and the seal of office on
Bridget C. Bohac DEC 04 2014
Bridget C. Bohac, Chief Clerk
Texas Commission on Environmental Quality

AMENDMENT TO CERTIFICATE OF ADJUDICATION

CERTIFICATE NO. 08-5035D TYPE: §§11.122

Owner:	Tarrant Regional Water District	Address:	P.O. Box 4508 Fort Worth, Texas 76164
Filed:	October 29, 2013	Granted:	November 25, 2014
Purposes:	Municipal, Mining, Industrial and Agricultural	Counties:	Freestone and Navarro
Watercourse:	Richland Creek, tributary of the Trinity River	Watershed:	Trinity River Basin

WHEREAS, Certificate of Adjudication No. 08-5035 authorizes Tarrant Regional Water District (TRWD or Owner) to maintain an existing dam and reservoir on Richland Creek (Richland-Chambers Reservoir), tributary of the Trinity River, Trinity River Basin and impound not to exceed 1,135,000 acre-feet of water; and

WHEREAS, Owner is also authorized to divert not to exceed 105,019 acre-feet of District Return Flows per year from the Trinity River at a maximum rate of 174.05 cfs (78,110 gpm) into an off-channel wetland impoundment with a storage capacity of 3,000 acre-feet for water quality treatment purposes, and to subsequently divert and store 100,465 acre-feet per year of those District Return Flows in Richland-Chambers Reservoir; and

WHEREAS, TRWD is further authorized to divert and use not to exceed 273,000 acre-feet of water from a point on the perimeter of Richland-Chambers Reservoir for municipal, mining, industrial and agricultural purposes within TRWD's service area in the Trinity River Basin with not to exceed 63,000 acre-feet of water per year diverted being accounted for as District Return Flows diverted from the Trinity River; and

WHEREAS, the Certificate also authorizes the use of the bed and banks of Alligator Creek to convey the District Return Flows to Richland-Chambers Reservoir; and

WHEREAS, multiple diversion rates, priority dates and special conditions apply; and

WHEREAS, TRWD has applied for an amendment to Certificate of Adjudication No. 08-5035 to increase the amount of District Return Flows authorized for diversion from Richland-Chambers Reservoir by an additional 37,465 acre-feet of water per year for a total of 100,465 acre-feet per year for municipal, mining, industrial and agricultural purposes within TRWD's service area in the Trinity River Basin; and

WHEREAS, TRWD does not request authorization to divert more water from the reservoir than they are currently authorized to discharge into Richland-Chambers Reservoir from the wetlands; and

WHEREAS, the Texas Commission on Environmental Quality (TCEQ or Commission) finds that jurisdiction over the application is established; and

WHEREAS, the Executive Director recommends that special conditions be included in the amendment; and

WHEREAS, one request for a contested case hearing was received for this application and was subsequently withdrawn; and

WHEREAS, the Commission has complied with the requirements of the Texas Water Code and Rules of the Texas Commission on Environmental Quality in issuing this amendment;

NOW, THEREFORE, this amendment to Certificate of Adjudication No. 08-5035, designated Certificate of Adjudication No. 08-5035D, is issued to Tarrant Regional Water District subject to the following terms and conditions:

1. USE

In lieu of the previous authorization in USE Paragraph 2.B., of Certificate of Adjudication No. 08-5035C to divert and use not to exceed 273,000 acre-feet of water per year from Richland-Chambers Reservoir for municipal, mining, industrial and agricultural purposes within TRWD's service area in the Trinity River Basin with not to exceed 63,000 acre-feet of water per year diverted being accounted for as District Return Flows diverted from the Trinity River, Owner is now authorized to divert and use not to exceed 310,465 acre-feet of water from Richland-Chambers Reservoir for municipal, mining, industrial and agricultural purposes within TRWD's service area in the Trinity River Basin with not to exceed 100,465 acre-feet of water per year diverted being accounted for as District Return Flows diverted from the Trinity River.

2. DIVERSION

In addition to the previous authorizations, Owner is authorized to divert the additional 37,465 acre-feet of water per year at those points on Richland-Chambers Reservoir currently authorized by this Certificate.

3. SPECIAL CONDITIONS

a. Owner shall only divert and use water in accordance with the most recently approved *Accounting Plan for the Tarrant Regional Water District's Water Supply*. Owner shall maintain the plan in electronic format and make the data available to the Executive Director upon request. Any modifications to the accounting plan shall be approved by the Executive Director. Any modification to the accounting plan that changes the terms of this certificate must be in the form of an amendment to the certificate. Should Owner fail to maintain the accounting plan or notify the Executive Director of any modifications to the plan, Owner shall immediately cease diversion of water and either apply to amend the certificate, or voluntarily forfeit the amendment. If Owner fails to amend the accounting plan or forfeit the amendment, the Commission may begin proceedings to cancel the amendment. Owner shall immediately notify the Executive Director upon modification of the accounting plan and provide copies of the appropriate documents effectuating such changes.

b. Ninety (90) days prior to the diversion of water for industrial, mining, or agricultural purposes, Owner shall submit to the TCEQ a water conservation plan to comply with Title 30 TAC Chapter 288.

4. CONSERVATION

Owner shall implement water conservation plans that provide for the utilization of those practices, techniques, and technologies that reduce or maintain the consumption of water, prevent or reduce the loss or waste of water, maintain or improve the efficiency in the use of water, increase the recycling and reuse of water, or prevent the pollution of water, so that a water supply is made available for future or alternative uses. Such plans shall include a requirement that in every wholesale water contract entered into on or after the effective date of this amendment, including any contract extension or renewal, that each successive wholesale customer develop and implement conservation measures. If the customer intends to resell the water, then the contract for resale of the water must have water conservation requirements so that each successive wholesale customer in the resale of the water be required to implement water conservation measures.

This amendment is issued subject to all terms, conditions, and provisions contained in Certificate of Adjudication No. 08-5035, as amended, except as specifically amended herein.

This amendment is issued subject to all superior and senior water rights in the Trinity River Basin.

Owner agrees to be bound by the terms, conditions, and provisions contained herein and such agreement is a condition precedent to the granting of this amendment.

All other matters requested in the application which are not specifically granted by this amendment are denied.

This amendment is issued subject to the Rules of the Texas Commission on Environmental Quality and to the right of continuing supervision of State resources exercised by the Commission.

For the Commission

Date Issued: **November 25, 2014**

THE STATE OF TEXAS
COUNTY OF FREESTONE
I Linda Jarvis Clerk of the County Court in and for Freestone County, Texas do hereby certify that this instrument was FILED FOR RECORD and RECORDED in the Volume and Page of the Official record and at the time and date stamped before me

County Clerk of Freestone County, Texas

FILED FOR RECORD IN
Freestone County
Lindo Jarvis
COUNTY CLERK
ON: Dec 17,2014 AT 02:55P
as Recordings
Document Number: 014D4164
Total Fees : 38.0D
Receipt Number - 128710
By, Sonomo Adkins, Deputy

(FDD)

STATE OF TEXAS §
§
COUNTY OF TARRANT §

SITE CERTIFICATE

Before me, the undersigned notary, on this day personally appeared **R. Steve Christian**, a person whose identity is known to me or who has presented to me a satisfactory proof of identity. After I administered an oath, this person swore to the following:

(1) My name is **R. Steve Christian**. I am over 18 years of age and I am of sound mind, and capable of swearing to the facts contained in this Site Certificate. The facts stated in this certificate are within my personal knowledge and are true and correct.

(2) I am an authorized representative of **Tarrant Regional Water District**, an entity that has filed an application for financial assistance with the Texas Water Development Board for a water project.

LEGAL CERTIFICATION – OWNERSHIP INTEREST

This is to certify that

Tarrant Regional Water District

has acquired or is in the process of acquiring the necessary real property interest, as evidenced by fee simple purchase or fully executed earnest money contracts, firm option agreements to purchase the subject property or the initiation of eminent domain procedures, that such acquisition will guarantee access and egress and such interest will contain the necessary easements, rights of way or unrestricted use as is required for the project being financed by the Texas Water Development Board. The legal description is referenced below:

The Integrated Pipeline Project spans Tarrant, Johnson, Ellis, Navarro, Henderson, and Anderson Counties. The property interests to be acquired for the project are Fee Simple and Easement estates.

——— Any deeds or other instruments required to be recorded to protect the title(s) held by **Tarrant Regional Water District** have been recorded or filed for the record in the County deed records or other required location.

LEGAL CERTIFICATION – LEASE/CONTRACT

In the alternative, I certify that

N/A

has executed a written lease or other contractual agreement to use the property needed for this (water) (wastewater) project that extends through **2019**, the life of the Texas Water Development Board loan or grant that will be used to finance this project, either in whole or in part. A copy of this lease or agreement is attached hereto.

LEGAL CERTIFICATION – PROPERTY EASEMENT

In the alternative, I certify that

Tarrant Regional Water District

has executed express easements to use the property needed for this water project that extends through **2019**, the life of the Texas Water Development Board loan or grant that will be used to finance this project, either in whole or in part. A copy of the form of express easement agreement is attached hereto.

EXECUTED this 5th day of May, 2015

(Signature)

R. Steve Christian
(Print Name)

Real Property Director
(Title)

Sworn to and subscribed before me by 5th on May, 2015.

RICHARD B. CARROLL NOTARY PUBLIC STATE OF TEXAS [SEAL] 03-27-2016

Notary Public in and for the State of Texas

My Commission expires: 3/27/2016

NOTICE OF CONFIDENTIALITY RIGHTS: IF YOU ARE A NATURAL PERSON, YOU MAY REMOVE OR STRIKE ANY OR ALL OF THE FOLLOWING INFORMATION FROM ANY INSTRUMENT THAT TRANSFERS AN INTEREST IN REAL PROPERTY BEFORE IT IS FILED FOR RECORD IN THE PUBLIC RECORDS: YOUR SOCIAL SECURITY NUMBER OR YOUR DRIVER'S LICENSE NUMBER.

WATER PIPELINE(S) EASEMENT AND RIGHT-OF-WAY

STATE OF TEXAS *

*

KNOW ALL PERSONS BY THESE PRESENTS:

COUNTY OF _____ *

That _____, a _____, whose address is _____ _____, _____, _____ (herein called "Grantor", whether one or more), for and in consideration of the sum of TEN AND NO/100 DOLLARS ($10.00) and other good and valuable consideration to Grantor in hand paid by TARRANT REGIONAL WATER DISTRICT, a Water Control and Improvement District, a body politic and corporate (herein called "Grantee"), whose mailing address is 800 East North Side Drive, Fort Worth, Texas 76102-1097, the receipt and sufficiency of which are hereby acknowledged, has BARGAINED, SOLD, GRANTED AND CONVEYED, and by these presents does BARGAIN, SELL, GRANT AND CONVEY unto the said Grantee, an easement and right-of-way to survey, perform tests, construct, install, operate, maintain, use, monitor, inspect, alter, relocate, replace, repair, and remove one or more water transportation pipelines (the "Pipeline(s)") and facilities (the "Appurtenant Facilities"), including above-ground and below-ground lines or facilities for electricity and for telephone or other communications or data transmission, water lines, cathodic protection equipment, and such other surface and subsurface equipment and facilities as may be necessary in the judgment of Grantee, in, on, under, over, and across the land described on Exhibit "A" (the "Land") attached hereto and incorporated herein for all purposes. It is expressly stipulated and agreed that multiple Pipelines and Appurtenant Facilities may be constructed, installed, operated, maintained, used, monitored, inspected, altered, relocated, removed, replaced, and repaired in, on, under, over, and across the Land and that such multiple Pipelines and Appurtenant Facilities need not be constructed or installed at the same time. Grantee may at any time construct, install, operate, maintain, use, monitor, inspect, alter, relocate, replace, repair, and remove additional Pipelines and Appurtenant Facilities above, below, or alongside any Pipeline(s) and Appurtenant Facilities constructed or installed in, on, under, over, or across the Land, without additional compensation to Grantor, including compensation for present or future grasses and growing crops disturbed by Grantee's uses of the Land.

The easement and associated rights granted hereby are sometimes collectively hereinafter referred to as the "Easement."

Grantee agrees and covenants that the Pipeline(s) will be buried so that the top(s) of said Pipeline(s) will be a minimum of forty inches (40") below the surface of the Land.

There is reserved from this conveyance and retained by Grantor all of the groundwater and all of the oil, gas, sulphur, and other gaseous minerals in, on or under the Land, but Grantor waives all rights of ingress and egress to or from the surface of the Land for the purposes of exploring, developing, mining, or drilling therefor; it being specifically agreed that no operations relating to such reservation will be conducted on the surface of the Land without Grantee's prior written permission. Grantor reserves the right to explore for, develop, and produce groundwater and minerals that may be produced through a wellbore provided that such water or minerals are produced by directional drilling or other means that do not require use of the surface of the Land and provided that such activities do not impact the lateral or subjacent support for the Pipeline(s) and Appurtenant Facilities or otherwise adversely impact the Easement granted hereby.

Grantee shall have full and unlimited access at all times along, upon, over, and through the Land for the purpose of surveying, performing tests, constructing, installing, maintaining, using, monitoring, operating, inspecting, altering, replacing, repairing, relocating, or removing Pipeline(s) and Appurtenant Facilities, including the right to patrol the Land on foot, with vehicles, and with aircraft. Grantee may cross fences, open gates, and reasonably traverse adjacent property as part of this access. If a pond, stock tank, creek, stream, freshet or other improvement or watercourse encroaches upon or exists or drains on the Land, Grantee shall have the right to remove, fill, redirect or otherwise remediate the impacts of any such improvement or condition, including by installing laterals, ditches or other facilities to direct or redirect water flows across the Land and shall have the right to enter upon and perform such activities on the adjacent lands of Grantor. Grantee shall also have the right to excavate, remove from the Land, and, at its option, replace soil, timber, gravel, rocks, and other materials and facilities found in, on, upon, or under the Land, and the consideration paid to Grantor includes all damages arising therefrom.

Grantor agrees not to erect, place, or permit any buildings, structures, or other improvements or obstructions on, in, or over the Land. Grantor shall make no commercial use of the Land except for agricultural uses permitted hereby. Grantor shall not conduct or allow any surface activity within a five (5) foot radius of any above-ground Appurtenant Facility. Grantor may use the Land for growing crops, provided that any such cultivation is no more than two (2) feet deep, and no cultivation may take place within a ten (10) foot radius of any above-ground Appurtenant Facility. Grantee has the right to remove any trees, woody plants, brush, and nursery stock planted or existing on the Land without liability therefor. Grantor may use the surface of the Land for grazing of livestock, provided that no livestock may be penned or concentrated on the Easement. Notwithstanding the foregoing, Grantor will not import to or otherwise cause to remain on or in close proximity to the Land any species designated as threatened or endangered or that is otherwise protected under the Endangered Species Act of 1973, as amended, or any similar or related Texas or federal law. With the prior written approval of Grantee, Grantor may use the surface of the Land for roads, paving, and for vehicular, pedestrian, and livestock ingress and egress so long as any such improvements and activities cross the Land at angles of approximately ninety (90) degrees, do not violate any applicable law, rule, regulation, or specification (including maximum surface loading limitations on the Pipeline(s) or Appurtenant Facilities), or endanger or interfere with the safety, efficiency, or convenient surveying, performance of tests, construction, installation, inspection, alteration, relocation, replacement, operation, repair, removal, or maintenance of the Pipeline(s) and Appurtenant Facilities or any other right of Grantee hereunder. Heavy loads exceeding the maximum surface loading limitations as provided by American Association of State Highway & Transportation Officials specification HS20 (16,000 pounds per wheel; 32,000 pounds per axle) may not be driven or otherwise transported on the Land on top of or parallel to the Pipeline(s) or Appurtenant Facilities without the prior written permission of Grantee. Grantor may place or allow the placement of below-ground utility lines for the purpose of providing utility service to the adjacent lands of Grantor so long as such line(s) do not run parallel to the Pipeline(s), cross the Pipeline(s) at an angle of approximately ninety (90) degrees, maintain at least a two-foot vertical separation from the Pipeline(s) and Appurtenant Facilities, and are buried and otherwise constructed in such a manner as to fully comply with all applicable rules, regulations, ordinances and laws, including, without limitation, casing and separation requirements imposed by the Texas Administrative Code, as amended, and so as not to endanger the Pipeline(s) or Appurtenant Facilities or otherwise interfere with the rights of Grantee hereunder. Grantor shall not take or permit any action that damages or endangers the Pipeline(s) or Appurtenant Facilities or the lateral or subjacent support therefor. Any prohibited use or installation on, over, or under the Land by or for Grantor will be removed by Grantee at Grantor's sole cost and expense, and Grantee shall have no liability arising therefrom.

Prior to the commencement of construction or the placement of anything in, upon, on, or under the Land, Grantor shall submit written plans therefor to Grantee, fully describing such proposed placement or construction and demonstrating, to Grantee's satisfaction, that such plans comply with the terms hereof and all applicable rules, regulations, and laws. No such placement or construction in, on, or under the Land shall commence until such plans have been approved in writing by Grantee to comply with the terms hereof and all applicable rules, regulations, ordinances, and laws. Grantor shall not excavate, remove, or place soil or other materials on or in the Land, or

otherwise change the surface contour thereof, without the prior written permission of Grantee. Grantor shall not install fencing on or across the Land without the written approval of Grantee, and Grantor agrees that any approved fencing will incorporate a gate (to be supplied by Grantee at its expense upon request by Grantor) of a size, design, and in a location determined by Grantee. Any such gate shall remain unblocked so as to allow Grantee access to the Land at all times. If any such gate requires a lock, Grantor agrees to coordinate with Grantee so that Grantee is allowed access to the Land at any and all times; Grantee may cut, remove, and replace locks which prevent Grantee from exercising its rights hereunder. Grantee shall have the right to construct a road across the Land to access the Pipeline(s) and Appurtenant Facilities for maintenance and other purposes. Grantor shall not use the Land for any type of storage, including the placement of automobiles or equipment on or in the Land. Grantor shall not use the Land for wastewater treatment or disposal. Grantor shall not construct any improvements for the diversion or impoundment of water, such as, but not limited to, wells, wetlands, ponds, canals, ditches or reservoirs in, upon, or over the Land. Grantor shall not include the Land within the boundaries of any platted lot that includes other land. Any plat of the Land as a separate lot must be approved in writing by Grantee. Grantor shall not tap into, connect with, or otherwise access the Pipeline(s) or Appurtenant Facilities.

Subject to the foregoing, Grantor shall have the right, subordinate to the rights of Grantee created hereby, to subject the Land to any use deemed desirable by Grantor so long as such use does not restrict the use of the Land, Easement, and appurtenant rights by Grantee and complies with the restrictions on Grantor's use set forth hereinabove.

It is understood that Grantee is acquiring the Easement for the purposes of constructing, installing, maintaining, using, monitoring, and operating the Pipeline(s) and Appurtenant Facilities for public purposes and uses, and that this negotiated sale is made in lieu of condemnation proceedings at law. The consideration paid to Grantor hereunder shall include and cover all claims and damages which Grantor could have asserted in condemnation proceedings, including damages to any adjoining property owned by Grantor and damages to the surface, including, but not limited to, grasses and growing crops, and includes compensation for the installation of Pipeline(s) and Appurtenant Facilities which Grantee may elect to install after the initial installation of Pipeline(s) or Appurtenant Facilities. It is expressly understood and agreed that Grantor shall be solely responsible for any claims of damages now or in the future by any grazing or agricultural tenant or others person claiming by, through or under Grantor. Grantee shall not be liable for any damages resulting from keeping the Land clear of trees, brush, undergrowth, and other obstructions in the course of surveying, performance of tests, constructing, operating, maintaining, using, monitoring, inspecting, altering, relocating, replacing, repairing, or removing the Pipeline(s) and Appurtenant Facilities.

TO HAVE AND TO HOLD the above-described Easement, together with all and singular the rights and appurtenances thereto in anywise belonging, to the Grantee, its successors and assigns, forever. Grantor does hereby bind Grantor, and Grantor's heirs, executors, administrators and assigns, to WARRANT AND FOREVER DEFEND all and singular the said Easements unto the Grantee, the said Tarrant Regional Water District, its successors and assigns, against every person whomsoever lawfully claiming or to claim the same or any part thereof, by, through, or under Grantor, but not otherwise, and subject to all matters of record.

The terms and provisions hereof shall inure to the benefit of and be binding upon Grantor and Grantee, and their respective heirs, executors, administrators, legal representatives, agents, servants, employees, contractors, successors and assigns, and shall be covenants running with the land. Nothing contained herein shall be construed to make Grantor and Grantee partners or joint venturers or to render either party liable for any obligation of the other.

This grant covers all of the agreements between the parties, and no prior representations or statements, verbal or written, have been made modifying, adding to, or changing the terms of this agreement. No amendments, modifications or revisions hereof shall be effective unless made in writing and signed by the parties hereto. This Water Pipeline(s) Easement and Right-of-Way shall be construed and enforced in accordance with the laws of the

State of Texas. Grantee, at its election, may record this instrument or may prepare, execute, and record a memorandum of same. Grantor will execute and acknowledge any such memorandum at Grantee's request.

The person executing this instrument on behalf of Grantor warrants and represents that he/she is duly authorized to execute and deliver this instrument on behalf of Grantor, and that same is the valid act and deed of Grantor, enforceable according to its terms.

EXECUTED this _____ day of _____, 20___.

_____,
a _____

By:_____
Its:_____

TARRANT REGIONAL WATER DISTRICT, a
Water Control and Improvement District

By: _____
R. Steve Christian
Real Property Director

STATE OF TEXAS *
*
COUNTY OF _____ *

This instrument was acknowledged before me on this _____ day of _____, 20___, by _____, the _____ of, a _____, on behalf of said _____.

_____
Notary Public for the State of Texas

STATE OF TEXAS *
*
COUNTY OF TARRANT *

The foregoing instrument was acknowledged before me on this _____ day of _____, 20___, by R. Steve Christian, Real Property Director of Tarrant Regional Water District, a Water Control and Improvement District, on behalf of said District.

_____
Notary Public for the State of Texas

AFTER RECORDING, RETURN TO:

Tarrant Regional Water District
P.O. Box 4508
Fort Worth, Texas 76164-0508
Attn: Mr. R. Steve Christian

P:\TRWD Palestine Connection Easement Easement 03-7-13.docx

DEPARTMENT OF THE ARMY
FORT WORTH DISTRICT, CORPS OF ENGINEERS
P.O. BOX 17300
FORT WORTH, TEXAS 76102-0300

REPLY TO
ATTENTION OF

September 17, 2013

Planning, Environmental, and Regulatory Division
Regulatory Branch

SUBJECT: Project Number SWF-2011-00074, Integrated Pipeline Project

Mr. Woody Frossard
Tarrant Regional Water District
800 East Northside Drive
Fort Worth, Texas 76102

Dear Mr. Frossard:

Thank you for your letter received May 22, 2013, and subsequent submittals received May 28, 2013, July 31, 2013, and August 5, 2013, concerning a proposal by the Tarrant Regional Water District to construct approximately 93 miles of 84- to 108-inch pipeline, from Cedar Creek and Richland Chambers Reservoirs westward to the Kennedale Balancing Reservoir starting in Henderson and Navarro Counties and crossing Ellis, Johnson, and Tarrant Counties, Texas. This project has been assigned Project Number SWF-2011-00074. Please include this number in all future correspondence concerning this project.

Under Section 404 of the Clean Water Act the U. S. Army Corps of Engineers (USACE) regulates the discharge of dredged and fill material into waters of the United States, including wetlands. USACE responsibility under Section 10 of the Rivers and Harbors Act of 1899 is to regulate any work in, or affecting, navigable waters of the United States. Based on your description of the proposed work, and other information available to us, we have determined this project will involve activities subject to the requirements of Section 404 and Section 10. The USACE based this decision on a preliminary jurisdictional determination that there are waters of the United States on the project site.

We have reviewed this project under the pre-construction notification procedures of Nationwide Permit General Condition 31 (Federal Register, Vol. 77, No. 34, Tuesday, February 21, 2012). We have determined this project is authorized by Nationwide Permit 12 for Utility Line Activities. To use this permit, the person responsible for the project must ensure the work is in compliance with the specifications and conditions listed on the enclosures and the special conditions listed below.

1. The permittee understands and agrees that, if future operations by the United States require the removal, relocation, or other alteration, of the structure or work herein authorized, or if, in the opinion of the Secretary of the Army or his authorized representative, said structure or work shall cause unreasonable obstruction to the free navigation of the navigable waters, the permittee will be required, upon due notice from the Corps of Engineers, to remove, relocate, or alter the structural work or obstructions caused thereby, without expense to the United States. No claim shall be made against the United States on account of any such removal or alteration.

2. The permittee shall implement and abide by the mitigation plan included in the "IPL Project – Preconstruction Notification," prepared by Freese and Nichols, Inc., dated May 2013. The permittee shall implement the mitigation plan concurrently with the construction of the project. Completion of all elements of this mitigation plan is a requirement of this permit.

3. The permittee shall implement and abide by invasive species controls included in the "Integrated Pipeline Project, IPL, Management of Invasive Species Study, Final Report," prepared by CH2MHill., dated August 2013.

4. The permittee shall not initiate any construction for this undertaking that will affect any identified historic property eligible, or potentially eligible for listing, in the National Register of Historic Places (NRHP) until the USACE has verified the requirements of 33 CFR 325 (Appendix C) and 36 CFR 800. After assessment by the USACE, additional work to protect, avoid, or mitigate impacts to historic properties may be necessary. If a previously unknown cultural resource site is encountered during work authorized by this permit, the permittee shall immediately contact the USACE and avoid further impact to the site until assessment, and the requirements for any additional work, are determined.

Failure to comply with these specifications and conditions invalidates the authorization and may result in a violation.

Our verification for the construction of this activity under this nationwide permit is valid until March 18, 2017, unless prior to that date the nationwide permit is suspended, revoked, or modified such that the activity would no longer comply with the terms and conditions of the nationwide permit on a regional or national basis. The USACE will issue a public notice announcing the changes when they occur. Furthermore, activities that have commenced, or are under contract to commence, in reliance on a nationwide permit will remain authorized provided the activity is completed within 12 months of the date of the nationwide permit's expiration, modification, or revocation, unless discretionary authority has been exercised on a case-by-case basis to modify, suspend, or revoke the authorization in accordance with 33 CFR 330.4(e) and 33 CFR 330.5(c) or (d).

Our review of this project also addressed its effects on threatened and endangered species. Based on the information provided, we have determined this project will not affect any species listed as threatened or endangered by the U.S. Fish and Wildlife Service within our permit area. However, please note you are responsible for meeting the requirements of General Condition 18 on endangered species.

The permittee must sign and submit to us the enclosed certification that the work, including any proposed mitigation, was completed in compliance with the nationwide permit. The permittee should submit the certification within 30 days of the completion of work.

This permit should not be considered as an approval of the design features of any activity authorized or an implication that such construction is considered adequate for the purpose intended. It does not authorize any damage to private property, invasion of property rights, or any infringement of federal, state, or local laws or regulations.

Thank you for your interest in our nation's water resources. If you have any questions concerning our regulatory program, please refer to our website at http://www.swf.usace.army.mil/Missions/Regulatory.aspx or contact Mr. Frederick Land at the address above or telephone (817) 886-1729.

Please help the Regulatory Program improve its service by completing the survey on the following website: http://per2.nwp.usace.army.mil/survey.html.

Sincerely,

for Stephen L Brooks
Chief, Regulatory Branch

Enclosures

Copy Furnish:

Mr. Steve Watters
Freese and Nichols, Inc.
4055 International Plaza, Suite 200
Fort Worth, Texas 76109

NATIONWIDE PERMIT 12

Utility Line Activities

Effective Date: March 19, 2012

(NWP Final Notice, 77 FR 10184)

Utility Line Activities. Activities required for the construction, maintenance, repair, and removal of utility lines and associated facilities in waters of the United States, provided the activity does not result in the loss of greater than 1/2-acre of waters of the United States for each single and complete project.

Utility lines: This NWP authorizes the construction, maintenance, or repair of utility lines, including outfall and intake structures, and the associated excavation, backfill, or bedding for the utility lines, in all waters of the United States, provided there is no change in pre-construction contours. A "utility line" is defined as any pipe or pipeline for the transportation of any gaseous, liquid, liquescent, or slurry substance, for any purpose, and any cable, line, or wire for the transmission for any purpose of electrical energy, telephone, and telegraph messages, and radio and television communication. The term "utility line" does not include activities that drain a water of the United States, such as drainage tile or french drains, but it does apply to pipes conveying drainage from another area.

Material resulting from trench excavation may be temporarily sidecast into waters of the United States for no more than three months, provided the material is not placed in such a manner that it is dispersed by currents or other forces. The district engineer may extend the period of temporary side casting for no more than a total of 180 days, where appropriate. In wetlands, the top 6 to 12 inches of the trench should normally be backfilled with topsoil from the trench. The trench cannot be constructed or backfilled in such a manner as to drain waters of the United States (e.g., backfilling with extensive gravel layers, creating a french drain effect). Any exposed slopes and stream banks must be stabilized immediately upon completion of the utility line crossing of each waterbody.

Utility line substations: This NWP authorizes the construction, maintenance, or expansion of substation facilities associated with a power line or utility line in non-tidal waters of the United States, provided the activity, in combination with all other activities included in one single and complete project, does not result in the loss of greater than 1/2-acre of waters of the United States. This NWP does not authorize discharges into non-tidal wetlands adjacent to tidal waters of the United States to construct, maintain, or expand substation facilities.

Foundations for overhead utility line towers, poles, and anchors: This NWP authorizes the construction or maintenance of foundations for overhead utility line towers, poles, and anchors in all waters of the United States, provided the foundations are the minimum size necessary and separate footings for each tower leg (rather than a larger single pad) are used where feasible.

Access roads: This NWP authorizes the construction of access roads for the construction and maintenance of utility lines, including overhead power lines and utility line substations, in non-tidal waters of the United States, provided the activity, in combination with all other activities included in one single and complete project, does not cause the loss of greater than 1/2-acre of non-tidal waters of the United States. This NWP does not authorize discharges into non-tidal wetlands adjacent to tidal waters for access roads. Access roads must be the minimum width necessary (see Note 2, below). Access roads must be constructed so that the length of the road minimizes any adverse effects on waters of the United States and must be as near as possible to pre-construction contours and elevations (e.g., at grade corduroy roads or geotextile/gravel

roads). Access roads constructed above pre-construction contours and elevations in waters of the United States must be properly bridged or culverted to maintain surface flows.

This NWP may authorize utility lines in or affecting navigable waters of the United States even if there is no associated discharge of dredged or fill material (See 33 CFR Part 322). Overhead utility lines constructed over section 10 waters and utility lines that are routed in or under section 10 waters without a discharge of dredged or fill material require a section 10 permit.

This NWP also authorizes temporary structures, fills, and work necessary to conduct the utility line activity. Appropriate measures must be taken to maintain normal downstream flows and minimize flooding to the maximum extent practicable, when temporary structures, work, and discharges, including cofferdams, are necessary for construction activities, access fills, or dewatering of construction sites. Temporary fills must consist of materials, and be placed in a manner, that will not be eroded by expected high flows. Temporary fills must be removed in their entirety and the affected areas returned to pre-construction elevations. The areas affected by temporary fills must be revegetated, as appropriate.

Notification: The permittee must submit a pre-construction notification to the district engineer prior to commencing the activity if any of the following criteria are met: (1) the activity involves mechanized land clearing in a forested wetland for the utility line right-of-way; (2) a section 10 permit is required; (3) the utility line in waters of the United States, excluding overhead lines, exceeds 500 feet; (4) the utility line is placed within a jurisdictional area (i.e., water of the United States), and it runs parallel to or along a stream bed that is within that jurisdictional area; (5) discharges that result in the loss of greater than 1/10-acre of waters of the United States; (6) permanent access roads are constructed above grade in waters of the United States for a distance of more than 500 feet; or (7) permanent access roads are constructed in waters of the United States with impervious materials. (See general condition 31.) (Sections 10 and 404)

Note 1: Where the proposed utility line is constructed or installed in navigable waters of the United States (i.e., section 10 waters) within the coastal United States, the Great Lakes, and United States territories, copies of the pre-construction notification and NWP verification will be sent by the Corps to the National Oceanic and Atmospheric Administration (NOAA), National Ocean Service (NOS), for charting the utility line to protect navigation.

Note 2: Access roads used for both construction and maintenance may be authorized, provided they meet the terms and conditions of this NWP. Access roads used solely for construction of the utility line must be removed upon completion of the work, in accordance with the requirements for temporary fills.

Note 3: Pipes or pipelines used to transport gaseous, liquid, liquescent, or slurry substances over navigable waters of the United States are considered to be bridges, not utility lines, and may require a permit from the U.S. Coast Guard pursuant to Section 9 of the Rivers and Harbors Act of 1899. However, any discharges of dredged or fill material into waters of the United States associated with such pipelines will require a section 404 permit (see NWP 15).

Note 4: For overhead utility lines authorized by this NWP, a copy of the PCN and NWP verification will be provided to the Department of Defense Siting Clearinghouse, which will evaluate potential effects on military activities.

Nationwide Permit General Conditions

Note: To qualify for NWP authorization, the prospective permittee must comply with the following general conditions, as applicable, in addition to any regional or case-specific conditions imposed by the division engineer or district engineer. Prospective permittees should contact the appropriate Corps district office to determine if regional conditions have been imposed on an NWP. Prospective permittees should also contact the appropriate Corps district office to determine the status of Clean Water Act Section 401 water quality certification and/or Coastal Zone Management Act consistency for an NWP. Every person who may wish to obtain permit authorization under one or more NWPs, or who is currently relying on an existing or prior permit authorization under one or more NWPs, has been and is on notice that all of the provisions of 33 CFR §§ 330.1 through 330.6 apply to every NWP authorization. Note especially 33 CFR § 330.5 relating to the modification, suspension, or revocation of any NWP authorization.

1. Navigation. (a) No activity may cause more than a minimal adverse effect on navigation.

(b) Any safety lights and signals prescribed by the U.S. Coast Guard, through regulations or otherwise, must be installed and maintained at the permittee's expense on authorized facilities in navigable waters of the United States.

(c) The permittee understands and agrees that, if future operations by the United States require the removal, relocation, or other alteration, of the structure or work herein authorized, or if, in the opinion of the Secretary of the Army or his authorized representative, said structure or work shall cause unreasonable obstruction to the free navigation of the navigable waters, the permittee will be required, upon due notice from the Corps of Engineers, to remove, relocate, or alter the structural work or obstructions caused thereby, without expense to the United States. No claim shall be made against the United States on account of any such removal or alteration.

2. Aquatic Life Movements. No activity may substantially disrupt the necessary life cycle movements of those species of aquatic life indigenous to the waterbody, including those species that normally migrate through the area, unless the activity's primary purpose is to impound water. All permanent and temporary crossings of waterbodies shall be suitably culverted, bridged, or otherwise designed and constructed to maintain low flows to sustain the movement of those aquatic species.

3. Spawning Areas. Activities in spawning areas during spawning seasons must be avoided to the maximum extent practicable. Activities that result in the physical destruction (e.g., through excavation, fill, or downstream smothering by substantial turbidity) of an important spawning area are not authorized.

4. Migratory Bird Breeding Areas. Activities in waters of the United States that serve as breeding areas for migratory birds must be avoided to the maximum extent practicable.

5. Shellfish Beds. No activity may occur in areas of concentrated shellfish populations, unless the activity is directly related to a shellfish harvesting activity authorized by NWPs 4 and 48, or is a shellfish seeding or habitat restoration activity authorized by NWP 27.

6. Suitable Material. No activity may use unsuitable material (e.g., trash, debris, car bodies, asphalt, etc.). Material used for construction or discharged must be free from toxic pollutants in toxic amounts (see Section 307 of the Clean Water Act).

7. Water Supply Intakes. No activity may occur in the proximity of a public water supply intake, except where the activity is for the repair or improvement of public water supply intake structures or adjacent bank stabilization.

8. Adverse Effects From Impoundments. If the activity creates an impoundment of water, adverse effects to the aquatic system due to accelerating the passage of water, and/or restricting its flow must be minimized to the maximum extent practicable.

9. Management of Water Flows. To the maximum extent practicable, the pre-construction course, condition, capacity, and location of open waters must be maintained for each activity, including stream channelization and storm water management activities, except as provided below. The activity must be constructed to withstand expected high flows. The activity must not restrict or impede the passage of normal or high flows, unless the primary purpose of the activity is to impound water or manage high flows. The activity may alter the pre-construction course, condition, capacity, and location of open waters if it benefits the aquatic environment (e.g., stream restoration or relocation activities).

10. Fills Within 100-Year Floodplains. The activity must comply with applicable FEMA-approved state or local floodplain management requirements.

11. Equipment. Heavy equipment working in wetlands or mudflats must be placed on mats, or other measures must be taken to minimize soil disturbance.

12. Soil Erosion and Sediment Controls. Appropriate soil erosion and sediment controls must be used and maintained in effective operating condition during construction, and all exposed soil and other fills, as well as any work below the ordinary high water mark or high tide line, must be permanently stabilized at the earliest practicable date. Permittees are encouraged to perform work within waters of the United States during periods of low-flow or no-flow.

13. Removal of Temporary Fills. Temporary fills must be removed in their entirety and the affected areas returned to pre-construction elevations. The affected areas must be revegetated, as appropriate.

14. Proper Maintenance. Any authorized structure or fill shall be properly maintained, including maintenance to ensure public safety and compliance with applicable NWP general conditions, as well as any activity-specific conditions added by the district engineer to an NWP authorization.

15. Single and Complete Project. The activity must be a single and complete project. The same NWP cannot be used more than once for the same single and complete project.

16. Wild and Scenic Rivers. No activity may occur in a component of the National Wild and Scenic River System, or in a river officially designated by Congress as a "study river" for possible inclusion in the system while the river is in an official study status, unless the appropriate Federal agency with direct management responsibility for such river, has determined in writing that the proposed activity will not adversely affect the Wild and Scenic River designation or study status. Information on Wild and Scenic Rivers may be obtained from the appropriate Federal land management agency responsible for the designated Wild and Scenic River or study river (e.g., National Park Service, U.S. Forest Service, Bureau of Land Management, U.S. Fish and Wildlife Service).

17. Tribal Rights. No activity or its operation may impair reserved tribal rights, including, but not limited to, reserved water rights and treaty fishing and hunting rights.

18. Endangered Species. (a) No activity is authorized under any NWP which is likely to directly or indirectly jeopardize the continued existence of a threatened or endangered species or a species proposed for such designation, as identified under the Federal Endangered Species Act (ESA), or which will directly or indirectly destroy or adversely modify the critical habitat of such species. No activity is authorized under any NWP which "may affect" a listed species or critical habitat, unless Section 7 consultation addressing the effects of the proposed activity has been completed.

(b) Federal agencies should follow their own procedures for complying with the requirements of the ESA. Federal permittees must provide the district engineer with the appropriate documentation to demonstrate compliance with those requirements. The district engineer will review the documentation and determine whether it is sufficient to address ESA compliance for the NWP activity, or whether additional ESA consultation is necessary.

(c) Non-federal permittees must submit a pre-construction notification to the district engineer if any listed species or designated critical habitat might be affected or is in the vicinity of the project, or if the project is located in designated critical habitat, and shall not begin work on the activity until notified by the district engineer that the requirements of the ESA have been satisfied and that the activity is authorized. For activities that might affect Federally-listed endangered or threatened species or designated critical habitat, the pre-construction notification must include the name(s) of the endangered or threatened species that might be affected by the proposed work or that utilize the designated critical habitat that might be affected by the proposed work. The district engineer will determine whether the proposed activity "may affect" or will have "no effect" to listed species and designated critical habitat and will notify the non-Federal applicant of the Corps' determination within 45 days of receipt of a complete pre-construction notification. In cases where the non-Federal applicant has identified listed species or critical habitat that might be affected or is in the vicinity of the project, and has so notified the Corps, the applicant shall not begin work until the Corps has provided notification the proposed activities will have "no effect" on listed species or critical habitat, or until Section 7 consultation has been completed. If the non-Federal applicant has not heard back from the Corps within 45 days, the applicant must still wait for notification from the Corps.

(d) As a result of formal or informal consultation with the FWS or NMFS the district engineer may add species-specific regional endangered species conditions to the NWPs.

(e) Authorization of an activity by a NWP does not authorize the "take" of a threatened or endangered species as defined under the ESA. In the absence of separate authorization (e.g., an

ESA Section 10 Permit, a Biological Opinion with “incidental take” provisions, etc.) from the U.S. FWS or the NMFS, The Endangered Species Act prohibits any person subject to the jurisdiction of the United States to take a listed species, where "take" means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. The word “harm” in the definition of “take" means an act which actually kills or injures wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering.

(f) Information on the location of threatened and endangered species and their critical habitat can be obtained directly from the offices of the U.S. FWS and NMFS or their world wide web pages at http://www.fws.gov/ or http://www.fws.gov/ipac and http://www.noaa.gov/fisheries.html respectively.

19. Migratory Birds and Bald and Golden Eagles. The permittee is responsible for obtaining any “take” permits required under the U.S. Fish and Wildlife Service’s regulations governing compliance with the Migratory Bird Treaty Act or the Bald and Golden Eagle Protection Act. The permittee should contact the appropriate local office of the U.S. Fish and Wildlife Service to determine if such “take” permits are required for a particular activity.

20. Historic Properties. (a) In cases where the district engineer determines that the activity may affect properties listed, or eligible for listing, in the National Register of Historic Places, the activity is not authorized, until the requirements of Section 106 of the National Historic Preservation Act (NHPA) have been satisfied.

(b) Federal permittees should follow their own procedures for complying with the requirements of Section 106 of the National Historic Preservation Act. Federal permittees must provide the district engineer with the appropriate documentation to demonstrate compliance with those requirements. The district engineer will review the documentation and determine whether it is sufficient to address section 106 compliance for the NWP activity, or whether additional section 106 consultation is necessary.

(c) Non-federal permittees must submit a pre-construction notification to the district engineer if the authorized activity may have the potential to cause effects to any historic properties listed on, determined to be eligible for listing on, or potentially eligible for listing on the National Register of Historic Places, including previously unidentified properties. For such activities, the pre-construction notification must state which historic properties may be affected by the proposed work or include a vicinity map indicating the location of the historic properties or the potential for the presence of historic properties. Assistance regarding information on the location of or potential for the presence of historic resources can be sought from the State Historic Preservation Officer or Tribal Historic Preservation Officer, as appropriate, and the National Register of Historic Places (see 33 CFR 330.4(g)). When reviewing pre-construction notifications, district engineers will comply with the current procedures for addressing the requirements of Section 106 of the National Historic Preservation Act. The district engineer shall make a reasonable and good faith effort to carry out appropriate identification efforts, which may include background research, consultation, oral history interviews, sample field investigation, and field survey. Based on the information submitted and these efforts, the district engineer shall determine whether the proposed activity has the potential to cause an effect on the historic properties. Where the non-Federal applicant has identified historic properties on which the

activity may have the potential to cause effects and so notified the Corps, the non-Federal applicant shall not begin the activity until notified by the district engineer either that the activity has no potential to cause effects or that consultation under Section 106 of the NHPA has been completed.

(d) The district engineer will notify the prospective permittee within 45 days of receipt of a complete pre-construction notification whether NHPA Section 106 consultation is required. Section 106 consultation is not required when the Corps determines that the activity does not have the potential to cause effects on historic properties (see 36 CFR §800.3(a)). If NHPA section 106 consultation is required and will occur, the district engineer will notify the non-Federal applicant that he or she cannot begin work until Section 106 consultation is completed. If the non-Federal applicant has not heard back from the Corps within 45 days, the applicant must still wait for notification from the Corps.

(e) Prospective permittees should be aware that section 110k of the NHPA (16 U.S.C. 470h-2(k)) prevents the Corps from granting a permit or other assistance to an applicant who, with intent to avoid the requirements of Section 106 of the NHPA, has intentionally significantly adversely affected a historic property to which the permit would relate, or having legal power to prevent it, allowed such significant adverse effect to occur, unless the Corps, after consultation with the Advisory Council on Historic Preservation (ACHP), determines that circumstances justify granting such assistance despite the adverse effect created or permitted by the applicant. If circumstances justify granting the assistance, the Corps is required to notify the ACHP and provide documentation specifying the circumstances, the degree of damage to the integrity of any historic properties affected, and proposed mitigation. This documentation must include any views obtained from the applicant, SHPO/THPO, appropriate Indian tribes if the undertaking occurs on or affects historic properties on tribal lands or affects properties of interest to those tribes, and other parties known to have a legitimate interest in the impacts to the permitted activity on historic properties.

21. Discovery of Previously Unknown Remains and Artifacts. If you discover any previously unknown historic, cultural or archeological remains and artifacts while accomplishing the activity authorized by this permit, you must immediately notify the district engineer of what you have found, and to the maximum extent practicable, avoid construction activities that may affect the remains and artifacts until the required coordination has been completed. The district engineer will initiate the Federal, Tribal and state coordination required to determine if the items or remains warrant a recovery effort or if the site is eligible for listing in the National Register of Historic Places.

22. Designated Critical Resource Waters. Critical resource waters include, NOAA-managed marine sanctuaries and marine monuments, and National Estuarine Research Reserves. The district engineer may designate, after notice and opportunity for public comment, additional waters officially designated by a state as having particular environmental or ecological significance, such as outstanding national resource waters or state natural heritage sites. The district engineer may also designate additional critical resource waters after notice and opportunity for public comment.

(a) Discharges of dredged or fill material into waters of the United States are not authorized by NWPs 7, 12, 14, 16, 17, 21, 29, 31, 35, 39, 40, 42, 43, 44, 49, 50, 51, and 52 for

any activity within, or directly affecting, critical resource waters, including wetlands adjacent to such waters.

(b) For NWPs 3, 8, 10, 13, 15, 18, 19, 22, 23, 25, 27, 28, 30, 33, 34, 36, 37, and 38, notification is required in accordance with general condition 31, for any activity proposed in the designated critical resource waters including wetlands adjacent to those waters. The district engineer may authorize activities under these NWPs only after it is determined that the impacts to the critical resource waters will be no more than minimal.

23. Mitigation. The district engineer will consider the following factors when determining appropriate and practicable mitigation necessary to ensure that adverse effects on the aquatic environment are minimal:

(a) The activity must be designed and constructed to avoid and minimize adverse effects, both temporary and permanent, to waters of the United States to the maximum extent practicable at the project site (i.e., on site).

(b) Mitigation in all its forms (avoiding, minimizing, rectifying, reducing, or compensating for resource losses) will be required to the extent necessary to ensure that the adverse effects to the aquatic environment are minimal.

(c) Compensatory mitigation at a minimum one-for-one ratio will be required for all wetland losses that exceed 1/10-acre and require pre-construction notification, unless the district engineer determines in writing that either some other form of mitigation would be more environmentally appropriate or the adverse effects of the proposed activity are minimal, and provides a project-specific waiver of this requirement. For wetland losses of 1/10-acre or less that require pre-construction notification, the district engineer may determine on a case-by-case basis that compensatory mitigation is required to ensure that the activity results in minimal adverse effects on the aquatic environment. Compensatory mitigation projects provided to offset losses of aquatic resources must comply with the applicable provisions of 33 CFR part 332.

(1) The prospective permittee is responsible for proposing an appropriate compensatory mitigation option if compensatory mitigation is necessary to ensure that the activity results in minimal adverse effects on the aquatic environment.

(2) Since the likelihood of success is greater and the impacts to potentially valuable uplands are reduced, wetland restoration should be the first compensatory mitigation option considered.

(3) If permittee-responsible mitigation is the proposed option, the prospective permittee is responsible for submitting a mitigation plan. A conceptual or detailed mitigation plan may be used by the district engineer to make the decision on the NWP verification request, but a final mitigation plan that addresses the applicable requirements of 33 CFR 332.4(c)(2) – (14) must be approved by the district engineer before the permittee begins work in waters of the United States, unless the district engineer determines that prior approval of the final mitigation plan is not practicable or not necessary to ensure timely completion of the required compensatory mitigation (see 33 CFR 332.3(k)(3)).

(4) If mitigation bank or in-lieu fee program credits are the proposed option, the mitigation plan only needs to address the baseline conditions at the impact site and the number of credits to be provided.

(5) Compensatory mitigation requirements (e.g., resource type and amount to be provided as compensatory mitigation, site protection, ecological performance standards, monitoring

requirements) may be addressed through conditions added to the NWP authorization, instead of components of a compensatory mitigation plan.

(d) For losses of streams or other open waters that require pre-construction notification, the district engineer may require compensatory mitigation, such as stream rehabilitation, enhancement, or preservation, to ensure that the activity results in minimal adverse effects on the aquatic environment.

(e) Compensatory mitigation will not be used to increase the acreage losses allowed by the acreage limits of the NWPs. For example, if an NWP has an acreage limit of 1/2-acre, it cannot be used to authorize any project resulting in the loss of greater than 1/2-acre of waters of the United States, even if compensatory mitigation is provided that replaces or restores some of the lost waters. However, compensatory mitigation can and should be used, as necessary, to ensure that a project already meeting the established acreage limits also satisfies the minimal impact requirement associated with the NWPs.

(f) Compensatory mitigation plans for projects in or near streams or other open waters will normally include a requirement for the restoration or establishment, maintenance, and legal protection (e.g., conservation easements) of riparian areas next to open waters. In some cases, riparian areas may be the only compensatory mitigation required. Riparian areas should consist of native species. The width of the required riparian area will address documented water quality or aquatic habitat loss concerns. Normally, the riparian area will be 25 to 50 feet wide on each side of the stream, but the district engineer may require slightly wider riparian areas to address documented water quality or habitat loss concerns. If it is not possible to establish a riparian area on both sides of a stream, or if the waterbody is a lake or coastal waters, then restoring or establishing a riparian area along a single bank or shoreline may be sufficient. Where both wetlands and open waters exist on the project site, the district engineer will determine the appropriate compensatory mitigation (e.g., riparian areas and/or wetlands compensation) based on what is best for the aquatic environment on a watershed basis. In cases where riparian areas are determined to be the most appropriate form of compensatory mitigation, the district engineer may waive or reduce the requirement to provide wetland compensatory mitigation for wetland losses.

(g) Permittees may propose the use of mitigation banks, in-lieu fee programs, or separate permittee-responsible mitigation. For activities resulting in the loss of marine or estuarine resources, permittee-responsible compensatory mitigation may be environmentally preferable if there are no mitigation banks or in-lieu fee programs in the area that have marine or estuarine credits available for sale or transfer to the permittee. For permittee-responsible mitigation, the special conditions of the NWP verification must clearly indicate the party or parties responsible for the implementation and performance of the compensatory mitigation project, and, if required, its long-term management.

(h) Where certain functions and services of waters of the United States are permanently adversely affected, such as the conversion of a forested or scrub-shrub wetland to a herbaceous wetland in a permanently maintained utility line right-of-way, mitigation may be required to reduce the adverse effects of the project to the minimal level.

24. Safety of Impoundment Structures. To ensure that all impoundment structures are safely designed, the district engineer may require non-Federal applicants to demonstrate that the structures comply with established state dam safety criteria or have been designed by qualified persons. The district engineer may also require documentation that the design has been

independently reviewed by similarly qualified persons, and appropriate modifications made to ensure safety.

25. Water Quality. Where States and authorized Tribes, or EPA where applicable, have not previously certified compliance of an NWP with CWA Section 401, individual 401 Water Quality Certification must be obtained or waived (see 33 CFR 330.4(c)). The district engineer or State or Tribe may require additional water quality management measures to ensure that the authorized activity does not result in more than minimal degradation of water quality.

26. Coastal Zone Management. In coastal states where an NWP has not previously received a state coastal zone management consistency concurrence, an individual state coastal zone management consistency concurrence must be obtained, or a presumption of concurrence must occur (see 33 CFR 330.4(d)). The district engineer or a State may require additional measures to ensure that the authorized activity is consistent with state coastal zone management requirements.

27. Regional and Case-By-Case Conditions. The activity must comply with any regional conditions that may have been added by the Division Engineer (see 33 CFR 330.4(e)) and with any case specific conditions added by the Corps or by the state, Indian Tribe, or U.S. EPA in its section 401 Water Quality Certification, or by the state in its Coastal Zone Management Act consistency determination.

28. Use of Multiple Nationwide Permits. The use of more than one NWP for a single and complete project is prohibited, except when the acreage loss of waters of the United States authorized by the NWPs does not exceed the acreage limit of the NWP with the highest specified acreage limit. For example, if a road crossing over tidal waters is constructed under NWP 14, with associated bank stabilization authorized by NWP 13, the maximum acreage loss of waters of the United States for the total project cannot exceed 1/3-acre.

29. Transfer of Nationwide Permit Verifications. If the permittee sells the property associated with a nationwide permit verification, the permittee may transfer the nationwide permit verification to the new owner by submitting a letter to the appropriate Corps district office to validate the transfer. A copy of the nationwide permit verification must be attached to the letter, and the letter must contain the following statement and signature:

"When the structures or work authorized by this nationwide permit are still in existence at the time the property is transferred, the terms and conditions of this nationwide permit, including any special conditions, will continue to be binding on the new owner(s) of the property. To validate the transfer of this nationwide permit and the associated liabilities associated with compliance with its terms and conditions, have the transferee sign and date below."

_____

(Transferee)

_____

(Date)

30. Compliance Certification. Each permittee who receives an NWP verification letter from the Corps must provide a signed certification documenting completion of the authorized activity and any required compensatory mitigation. The success of any required permittee-responsible mitigation, including the achievement of ecological performance standards, will be addressed separately by the district engineer. The Corps will provide the permittee the certification document with the NWP verification letter. The certification document will include:

(a) A statement that the authorized work was done in accordance with the NWP authorization, including any general, regional, or activity-specific conditions;

(b) A statement that the implementation of any required compensatory mitigation was completed in accordance with the permit conditions. If credits from a mitigation bank or in-lieu fee program are used to satisfy the compensatory mitigation requirements, the certification must include the documentation required by 33 CFR 332.3(l)(3) to confirm that the permittee secured the appropriate number and resource type of credits; and

(c) The signature of the permittee certifying the completion of the work and mitigation.

31. Pre-Construction Notification. (a) Timing. Where required by the terms of the NWP, the prospective permittee must notify the district engineer by submitting a pre-construction notification (PCN) as early as possible. The district engineer must determine if the PCN is complete within 30 calendar days of the date of receipt and, if the PCN is determined to be incomplete, notify the prospective permittee within that 30 day period to request the additional information necessary to make the PCN complete. The request must specify the information needed to make the PCN complete. As a general rule, district engineers will request additional information necessary to make the PCN complete only once. However, if the prospective permittee does not provide all of the requested information, then the district engineer will notify the prospective permittee that the PCN is still incomplete and the PCN review process will not commence until all of the requested information has been received by the district engineer. The prospective permittee shall not begin the activity until either:

(1) He or she is notified in writing by the district engineer that the activity may proceed under the NWP with any special conditions imposed by the district or division engineer; or

(2) 45 calendar days have passed from the district engineer's receipt of the complete PCN and the prospective permittee has not received written notice from the district or division engineer. However, if the permittee was required to notify the Corps pursuant to general condition 18 that listed species or critical habitat might be affected or in the vicinity of the project, or to notify the Corps pursuant to general condition 20 that the activity may have the potential to cause effects to historic properties, the permittee cannot begin the activity until receiving written notification from the Corps that there is "no effect" on listed species or "no potential to cause effects" on historic properties, or that any consultation required under Section 7 of the Endangered Species Act (see 33 CFR 330.4(f)) and/or Section 106 of the National Historic Preservation (see 33 CFR 330.4(g)) has been completed. Also, work cannot begin under NWPs 21, 49, or 50 until the permittee has received written approval from the Corps. If the proposed activity requires a written waiver to exceed specified limits of an NWP, the permittee may not begin the activity until the district engineer issues the waiver. If the district or division engineer notifies the permittee in writing that an individual permit is required within 45 calendar days of receipt of a complete PCN, the permittee cannot begin the activity until an individual

permit has been obtained. Subsequently, the permittee's right to proceed under the NWP may be modified, suspended, or revoked only in accordance with the procedure set forth in 33 CFR 330.5(d)(2).

(b) Contents of Pre-Construction Notification: The PCN must be in writing and include the following information:

(1) Name, address and telephone numbers of the prospective permittee;

(2) Location of the proposed project;

(3) A description of the proposed project; the project's purpose; direct and indirect adverse environmental effects the project would cause, including the anticipated amount of loss of water of the United States expected to result from the NWP activity, in acres, linear feet, or other appropriate unit of measure; any other NWP(s), regional general permit(s), or individual permit(s) used or intended to be used to authorize any part of the proposed project or any related activity. The description should be sufficiently detailed to allow the district engineer to determine that the adverse effects of the project will be minimal and to determine the need for compensatory mitigation. Sketches should be provided when necessary to show that the activity complies with the terms of the NWP. (Sketches usually clarify the project and when provided results in a quicker decision. Sketches should contain sufficient detail to provide an illustrative description of the proposed activity (e.g., a conceptual plan), but do not need to be detailed engineering plans);

(4) The PCN must include a delineation of wetlands, other special aquatic sites, and other waters, such as lakes and ponds, and perennial, intermittent, and ephemeral streams, on the project site. Wetland delineations must be prepared in accordance with the current method required by the Corps. The permittee may ask the Corps to delineate the special aquatic sites and other waters on the project site, but there may be a delay if the Corps does the delineation, especially if the project site is large or contains many waters of the United States. Furthermore, the 45 day period will not start until the delineation has been submitted to or completed by the Corps, as appropriate;

(5) If the proposed activity will result in the loss of greater than 1/10-acre of wetlands and a PCN is required, the prospective permittee must submit a statement describing how the mitigation requirement will be satisfied, or explaining why the adverse effects are minimal and why compensatory mitigation should not be required. As an alternative, the prospective permittee may submit a conceptual or detailed mitigation plan.

(6) If any listed species or designated critical habitat might be affected or is in the vicinity of the project, or if the project is located in designated critical habitat, for non-Federal applicants the PCN must include the name(s) of those endangered or threatened species that might be affected by the proposed work or utilize the designated critical habitat that may be affected by the proposed work. Federal applicants must provide documentation demonstrating compliance with the Endangered Species Act; and

(7) For an activity that may affect a historic property listed on, determined to be eligible for listing on, or potentially eligible for listing on, the National Register of Historic Places, for non-Federal applicants the PCN must state which historic property may be affected by the proposed work or include a vicinity map indicating the location of the historic property. Federal applicants must provide documentation demonstrating compliance with Section 106 of the National Historic Preservation Act.

(c) Form of Pre-Construction Notification: The standard individual permit application form (Form ENG 4345) may be used, but the completed application form must clearly indicate

that it is a PCN and must include all of the information required in paragraphs (b)(1) through (7) of this general condition. A letter containing the required information may also be used.

(d) Agency Coordination: (1) The district engineer will consider any comments from Federal and state agencies concerning the proposed activity's compliance with the terms and conditions of the NWPs and the need for mitigation to reduce the project's adverse environmental effects to a minimal level.

(2) For all NWP activities that require pre-construction notification and result in the loss of greater than 1/2-acre of waters of the United States, for NWP 21, 29, 39, 40, 42, 43, 44, 50, 51, and 52 activities that require pre-construction notification and will result in the loss of greater than 300 linear feet of intermittent and ephemeral stream bed, and for all NWP 48 activities that require pre-construction notification, the district engineer will immediately provide (e.g., via e-mail, facsimile transmission, overnight mail, or other expeditious manner) a copy of the complete PCN to the appropriate Federal or state offices (U.S. FWS, state natural resource or water quality agency, EPA, State Historic Preservation Officer (SHPO) or Tribal Historic Preservation Office (THPO), and, if appropriate, the NMFS). With the exception of NWP 37, these agencies will have 10 calendar days from the date the material is transmitted to telephone or fax the district engineer notice that they intend to provide substantive, site-specific comments. The comments must explain why the agency believes the adverse effects will be more than minimal. If so contacted by an agency, the district engineer will wait an additional 15 calendar days before making a decision on the pre-construction notification. The district engineer will fully consider agency comments received within the specified time frame concerning the proposed activity's compliance with the terms and conditions of the NWPs, including the need for mitigation to ensure the net adverse environmental effects to the aquatic environment of the proposed activity are minimal. The district engineer will provide no response to the resource agency, except as provided below. The district engineer will indicate in the administrative record associated with each pre-construction notification that the resource agencies' concerns were considered. For NWP 37, the emergency watershed protection and rehabilitation activity may proceed immediately in cases where there is an unacceptable hazard to life or a significant loss of property or economic hardship will occur. The district engineer will consider any comments received to decide whether the NWP 37 authorization should be modified, suspended, or revoked in accordance with the procedures at 33 CFR 330.5.

(3) In cases of where the prospective permittee is not a Federal agency, the district engineer will provide a response to NMFS within 30 calendar days of receipt of any Essential Fish Habitat conservation recommendations, as required by Section 305(b)(4)(B) of the Magnuson-Stevens Fishery Conservation and Management Act.

(4) Applicants are encouraged to provide the Corps with either electronic files or multiple copies of pre-construction notifications to expedite agency coordination.

D. District Engineer's Decision

1. In reviewing the PCN for the proposed activity, the district engineer will determine whether the activity authorized by the NWP will result in more than minimal individual or cumulative adverse environmental effects or may be contrary to the public interest. For a linear project, this determination will include an evaluation of the individual crossings to determine whether they individually satisfy the terms and conditions of the NWP(s), as well as the cumulative effects caused by all of the crossings authorized by NWP. If an applicant requests a

waiver of the 300 linear foot limit on impacts to intermittent or ephemeral streams or of an otherwise applicable limit, as provided for in NWPs 13, 21, 29, 36, 39, 40, 42, 43, 44, 50, 51 or 52, the district engineer will only grant the waiver upon a written determination that the NWP activity will result in minimal adverse effects. When making minimal effects determinations the district engineer will consider the direct and indirect effects caused by the NWP activity. The district engineer will also consider site specific factors, such as the environmental setting in the vicinity of the NWP activity, the type of resource that will be affected by the NWP activity, the functions provided by the aquatic resources that will be affected by the NWP activity, the degree or magnitude to which the aquatic resources perform those functions, the extent that aquatic resource functions will be lost as a result of the NWP activity (e.g., partial or complete loss), the duration of the adverse effects (temporary or permanent), the importance of the aquatic resource functions to the region (e.g., watershed or ecoregion), and mitigation required by the district engineer. If an appropriate functional assessment method is available and practicable to use, that assessment method may be used by the district engineer to assist in the minimal adverse effects determination. The district engineer may add case-specific special conditions to the NWP authorization to address site-specific environmental concerns.

2. If the proposed activity requires a PCN and will result in a loss of greater than 1/10-acre of wetlands, the prospective permittee should submit a mitigation proposal with the PCN. Applicants may also propose compensatory mitigation for projects with smaller impacts. The district engineer will consider any proposed compensatory mitigation the applicant has included in the proposal in determining whether the net adverse environmental effects to the aquatic environment of the proposed activity are minimal. The compensatory mitigation proposal may be either conceptual or detailed. If the district engineer determines that the activity complies with the terms and conditions of the NWP and that the adverse effects on the aquatic environment are minimal, after considering mitigation, the district engineer will notify the permittee and include any activity-specific conditions in the NWP verification the district engineer deems necessary. Conditions for compensatory mitigation requirements must comply with the appropriate provisions at 33 CFR 332.3(k). The district engineer must approve the final mitigation plan before the permittee commences work in waters of the United States, unless the district engineer determines that prior approval of the final mitigation plan is not practicable or not necessary to ensure timely completion of the required compensatory mitigation. If the prospective permittee elects to submit a compensatory mitigation plan with the PCN, the district engineer will expeditiously review the proposed compensatory mitigation plan. The district engineer must review the proposed compensatory mitigation plan within 45 calendar days of receiving a complete PCN and determine whether the proposed mitigation would ensure no more than minimal adverse effects on the aquatic environment. If the net adverse effects of the project on the aquatic environment (after consideration of the compensatory mitigation proposal) are determined by the district engineer to be minimal, the district engineer will provide a timely written response to the applicant. The response will state that the project can proceed under the terms and conditions of the NWP, including any activity-specific conditions added to the NWP authorization by the district engineer.

3. If the district engineer determines that the adverse effects of the proposed work are more than minimal, then the district engineer will notify the applicant either: (a) That the project does not qualify for authorization under the NWP and instruct the applicant on the procedures to

seek authorization under an individual permit; (b) that the project is authorized under the NWP subject to the applicant's submission of a mitigation plan that would reduce the adverse effects on the aquatic environment to the minimal level; or (c) that the project is authorized under the NWP with specific modifications or conditions. Where the district engineer determines that mitigation is required to ensure no more than minimal adverse effects occur to the aquatic environment, the activity will be authorized within the 45-day PCN period, with activity-specific conditions that state the mitigation requirements. The authorization will include the necessary conceptual or detailed mitigation or a requirement that the applicant submit a mitigation plan that would reduce the adverse effects on the aquatic environment to the minimal level. When mitigation is required, no work in waters of the United States may occur until the district engineer has approved a specific mitigation plan or has determined that prior approval of a final mitigation plan is not practicable or not necessary to ensure timely completion of the required compensatory mitigation.

E. Further Information

1. District Engineers have authority to determine if an activity complies with the terms and conditions of an NWP.

2. NWPs do not obviate the need to obtain other federal, state, or local permits, approvals, or authorizations required by law.

3. NWPs do not grant any property rights or exclusive privileges.

4. NWPs do not authorize any injury to the property or rights of others.

5. NWPs do not authorize interference with any existing or proposed Federal project.

F. Definitions

Best management practices (BMPs): Policies, practices, procedures, or structures implemented to mitigate the adverse environmental effects on surface water quality resulting from development. BMPs are categorized as structural or non-structural.

Compensatory mitigation: The restoration (re-establishment or rehabilitation), establishment (creation), enhancement, and/or in certain circumstances preservation of aquatic resources for the purposes of offsetting unavoidable adverse impacts which remain after all appropriate and practicable avoidance and minimization has been achieved.

Currently serviceable: Useable as is or with some maintenance, but not so degraded as to essentially require reconstruction.

Direct effects: Effects that are caused by the activity and occur at the same time and place.

Discharge: The term "discharge" means any discharge of dredged or fill material.

Enhancement: The manipulation of the physical, chemical, or biological characteristics of an aquatic resource to heighten, intensify, or improve a specific aquatic resource function(s). Enhancement results in the gain of selected aquatic resource function(s), but may also lead to a decline in other aquatic resource function(s). Enhancement does not result in a gain in aquatic resource area.

Ephemeral stream: An ephemeral stream has flowing water only during, and for a short duration after, precipitation events in a typical year. Ephemeral stream beds are located above the

water table year-round. Groundwater is not a source of water for the stream. Runoff from rainfall is the primary source of water for stream flow.

Establishment (creation): The manipulation of the physical, chemical, or biological characteristics present to develop an aquatic resource that did not previously exist at an upland site. Establishment results in a gain in aquatic resource area.

High Tide Line: The line of intersection of the land with the water's surface at the maximum height reached by a rising tide. The high tide line may be determined, in the absence of actual data, by a line of oil or scum along shore objects, a more or less continuous deposit of fine shell or debris on the foreshore or berm, other physical markings or characteristics, vegetation lines, tidal gages, or other suitable means that delineate the general height reached by a rising tide. The line encompasses spring high tides and other high tides that occur with periodic frequency but does not include storm surges in which there is a departure from the normal or predicted reach of the tide due to the piling up of water against a coast by strong winds such as those accompanying a hurricane or other intense storm.

Historic Property: Any prehistoric or historic district, site (including archaeological site), building, structure, or other object included in, or eligible for inclusion in, the National Register of Historic Places maintained by the Secretary of the Interior. This term includes artifacts, records, and remains that are related to and located within such properties. The term includes properties of traditional religious and cultural importance to an Indian tribe or Native Hawaiian organization and that meet the National Register criteria (36 CFR part 60).

Independent utility: A test to determine what constitutes a single and complete non-linear project in the Corps regulatory program. A project is considered to have independent utility if it would be constructed absent the construction of other projects in the project area. Portions of a multi-phase project that depend upon other phases of the project do not have independent utility. Phases of a project that would be constructed even if the other phases were not built can be considered as separate single and complete projects with independent utility.

Indirect effects: Effects that are caused by the activity and are later in time or farther removed in distance, but are still reasonably foreseeable.

Intermittent stream: An intermittent stream has flowing water during certain times of the year, when groundwater provides water for stream flow. During dry periods, intermittent streams may not have flowing water. Runoff from rainfall is a supplemental source of water for stream flow.

Loss of waters of the United States: Waters of the United States that are permanently adversely affected by filling, flooding, excavation, or drainage because of the regulated activity. Permanent adverse effects include permanent discharges of dredged or fill material that change an aquatic area to dry land, increase the bottom elevation of a waterbody, or change the use of a waterbody. The acreage of loss of waters of the United States is a threshold measurement of the impact to jurisdictional waters for determining whether a project may qualify for an NWP; it is not a net threshold that is calculated after considering compensatory mitigation that may be used to offset losses of aquatic functions and services. The loss of stream bed includes the linear feet of stream bed that is filled or excavated. Waters of the United States temporarily filled, flooded, excavated, or drained, but restored to pre-construction contours and elevations after construction, are not included in the measurement of loss of waters of the United States. Impacts resulting from activities eligible for exemptions under Section 404(f) of the Clean Water Act are not considered when calculating the loss of waters of the United States.

Non-tidal wetland: A non-tidal wetland is a wetland that is not subject to the ebb and flow of tidal waters. The definition of a wetland can be found at 33 CFR 328.3(b). Non-tidal wetlands contiguous to tidal waters are located landward of the high tide line (i.e., spring high tide line).

Open water: For purposes of the NWPs, an open water is any area that in a year with normal patterns of precipitation has water flowing or standing above ground to the extent that an ordinary high water mark can be determined. Aquatic vegetation within the area of standing or flowing water is either non-emergent, sparse, or absent. Vegetated shallows are considered to be open waters. Examples of "open waters" include rivers, streams, lakes, and ponds.

Ordinary High Water Mark: An ordinary high water mark is a line on the shore established by the fluctuations of water and indicated by physical characteristics, or by other appropriate means that consider the characteristics of the surrounding areas (see 33 CFR 328.3(e)).

Perennial stream: A perennial stream has flowing water year-round during a typical year. The water table is located above the stream bed for most of the year. Groundwater is the primary source of water for stream flow. Runoff from rainfall is a supplemental source of water for stream flow.

Practicable: Available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes.

Pre-construction notification: A request submitted by the project proponent to the Corps for confirmation that a particular activity is authorized by nationwide permit. The request may be a permit application, letter, or similar document that includes information about the proposed work and its anticipated environmental effects. Pre-construction notification may be required by the terms and conditions of a nationwide permit, or by regional conditions. A pre-construction notification may be voluntarily submitted in cases where pre-construction notification is not required and the project proponent wants confirmation that the activity is authorized by nationwide permit.

Preservation: The removal of a threat to, or preventing the decline of, aquatic resources by an action in or near those aquatic resources. This term includes activities commonly associated with the protection and maintenance of aquatic resources through the implementation of appropriate legal and physical mechanisms. Preservation does not result in a gain of aquatic resource area or functions.

Re-establishment: The manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural/historic functions to a former aquatic resource. Re-establishment results in rebuilding a former aquatic resource and results in a gain in aquatic resource area and functions.

Rehabilitation: The manipulation of the physical, chemical, or biological characteristics of a site with the goal of repairing natural/historic functions to a degraded aquatic resource. Rehabilitation results in a gain in aquatic resource function, but does not result in a gain in aquatic resource area.

Restoration: The manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural/historic functions to a former or degraded aquatic resource. For the purpose of tracking net gains in aquatic resource area, restoration is divided into two categories: re-establishment and rehabilitation.

Riffle and pool complex: Riffle and pool complexes are special aquatic sites under the 404(b)(1) Guidelines. Riffle and pool complexes sometimes characterize steep gradient sections

of streams. Such stream sections are recognizable by their hydraulic characteristics. The rapid movement of water over a course substrate in riffles results in a rough flow, a turbulent surface, and high dissolved oxygen levels in the water. Pools are deeper areas associated with riffles. A slower stream velocity, a streaming flow, a smooth surface, and a finer substrate characterize pools.

Riparian areas: Riparian areas are lands adjacent to streams, lakes, and estuarine-marine shorelines. Riparian areas are transitional between terrestrial and aquatic ecosystems, through which surface and subsurface hydrology connects riverine, lacustrine, estuarine, and marine waters with their adjacent wetlands, non-wetland waters, or uplands. Riparian areas provide a variety of ecological functions and services and help improve or maintain local water quality. (See general condition 23.)

Shellfish seeding: The placement of shellfish seed and/or suitable substrate to increase shellfish production. Shellfish seed consists of immature individual shellfish or individual shellfish attached to shells or shell fragments (i.e., spat on shell). Suitable substrate may consist of shellfish shells, shell fragments, or other appropriate materials placed into waters for shellfish habitat.

Single and complete linear project: A linear project is a project constructed for the purpose of getting people, goods, or services from a point of origin to a terminal point, which often involves multiple crossings of one or more waterbodies at separate and distant locations. The term "single and complete project" is defined as that portion of the total linear project proposed or accomplished by one owner/developer or partnership or other association of owners/developers that includes all crossings of a single water of the United States (i.e., a single waterbody) at a specific location. For linear projects crossing a single or multiple waterbodies several times at separate and distant locations, each crossing is considered a single and complete project for purposes of NWP authorization. However, individual channels in a braided stream or river, or individual arms of a large, irregularly shaped wetland or lake, etc., are not separate waterbodies, and crossings of such features cannot be considered separately.

Single and complete non-linear project: For non-linear projects, the term "single and complete project" is defined at 33 CFR 330.2(i) as the total project proposed or accomplished by one owner/developer or partnership or other association of owners/developers. A single and complete non-linear project must have independent utility (see definition of "independent utility"). Single and complete non-linear projects may not be "piecemealed" to avoid the limits in an NWP authorization.

Stormwater management: Stormwater management is the mechanism for controlling stormwater runoff for the purposes of reducing downstream erosion, water quality degradation, and flooding and mitigating the adverse effects of changes in land use on the aquatic environment.

Stormwater management facilities: Stormwater management facilities are those facilities, including but not limited to, stormwater retention and detention ponds and best management practices, which retain water for a period of time to control runoff and/or improve the quality (i.e., by reducing the concentration of nutrients, sediments, hazardous substances and other pollutants) of stormwater runoff.

Stream bed: The substrate of the stream channel between the ordinary high water marks. The substrate may be bedrock or inorganic particles that range in size from clay to boulders. Wetlands contiguous to the stream bed, but outside of the ordinary high water marks, are not considered part of the stream bed.

Stream channelization: The manipulation of a stream's course, condition, capacity, or location that causes more than minimal interruption of normal stream processes. A channelized stream remains a water of the United States.

Structure: An object that is arranged in a definite pattern of organization. Examples of structures include, without limitation, any pier, boat dock, boat ramp, wharf, dolphin, weir, boom, breakwater, bulkhead, revetment, riprap, jetty, artificial island, artificial reef, permanent mooring structure, power transmission line, permanently moored floating vessel, piling, aid to navigation, or any other manmade obstacle or obstruction.

Tidal wetland: A tidal wetland is a wetland (i.e., water of the United States) that is inundated by tidal waters. The definitions of a wetland and tidal waters can be found at 33 CFR 328.3(b) and 33 CFR 328.3(f), respectively. Tidal waters rise and fall in a predictable and measurable rhythm or cycle due to the gravitational pulls of the moon and sun. Tidal waters end where the rise and fall of the water surface can no longer be practically measured in a predictable rhythm due to masking by other waters, wind, or other effects. Tidal wetlands are located channelward of the high tide line, which is defined at 33 CFR 328.3(d).

Vegetated shallows: Vegetated shallows are special aquatic sites under the 404(b)(1) Guidelines. They are areas that are permanently inundated and under normal circumstances have rooted aquatic vegetation, such as seagrasses in marine and estuarine systems and a variety of vascular rooted plants in freshwater systems.

Waterbody: For purposes of the NWPs, a waterbody is a jurisdictional water of the United States. If a jurisdictional wetland is adjacent – meaning bordering, contiguous, or neighboring – to a waterbody determined to be a water of the United States under 33 CFR 328.3(a)(1)-(6), that waterbody and its adjacent wetlands are considered together as a single aquatic unit (see 33 CFR 328.4(c)(2)). Examples of "waterbodies" include streams, rivers, lakes, ponds, and wetlands.

ADDITIONAL INFORMATION

This nationwide permit is effective March 19, 2012, and expires on March 18, 2017.

Information about the U.S. Army Corps of Engineers regulatory program, including nationwide permits, may also be accessed at http://www.swf.usace.army.mil/regulatory or http://www.usace.army.mil/Missions/CivilWorks/RegulatoryProgramandPermits.aspx

NATIONWIDE PERMIT (NWP) REGIONAL CONDITIONS FOR THE STATE OF TEXAS

The following regional conditions apply within the entire State of Texas:

1. Compensatory mitigation is required at a minimum one-for-one ratio for all special aquatic site losses that exceed 1/10 acre and require pre-construction notification (PCN), and for all losses to streams that exceed 300 linear feet and require PCN, unless the appropriate District Engineer determines in writing that some other form of mitigation would be more environmentally appropriate and provides a project-specific waiver of this requirement.

2. For all discharges proposed for authorization under nationwide permits (NWP) 3, 6, 7, 12, 14, 18, 19, 25, 27, 29, 39, 40, 41, 42, 43, 44, 51, and 52, into the following habitat types or specific areas, the applicant shall notify the appropriate District Engineer in accordance with the NWP General Condition 31, Pre-Construction Notification (PCN). The Corps of Engineers (Corps), except for the Tulsa District, will coordinate with the resource agencies as specified in NWP General Condition 31(d) (PCN). The habitat types or areas are:

a. Pitcher Plant Bogs: Wetlands typically characterized by an organic surface soil layer and include vegetation such as pitcher plants (Sarracenia sp.), sundews (Drosera sp.), and sphagnum moss (Sphagnum sp.).

b. Bald Cypress-Tupelo Swamps: Wetlands comprised predominantly of bald cypress trees (Taxodium distichum), and water tupelo trees (Nyssa aquatica), that are occasionally or regularly flooded by fresh water. Common associates include red maple (Acer rubrum), swamp privet (Forestiera acuminata), green ash (Fraxinus pennsylvanica) and water elm (Planera aquatica). Associated herbaceous species include lizard's tail (Saururus cernuus), water mermaid weed (Proserpinaca spp.), buttonbush (Cephalanthus occidentalis) and smartweed (Polygonum spp.). (Eyre, F. H. Forest Cover Types of the United States and Canada. 1980. Society of American Foresters, 5400 Grosvenor Lane, Bethesda, Maryland 20814-2198. Library of Congress Catalog Card No. 80-54185)

3. For all activities proposed for authorization under NWP 12 that involve a discharge of fill material associated with mechanized land clearing in a forested wetland, the applicant shall notify the appropriate District Engineer in accordance with the NWP General Condition 31 (Pre-Construction Notification) prior to commencing the activity.

4. For all activities proposed for authorization under NWP 16, the applicant shall notify the appropriate District Engineer in accordance with the NWP General Condition 31 (Pre-Construction Notification), and work cannot begin under NWP 16 until the applicant has received written approval from the Corps.

The following regional conditions apply only within the Fort Worth District in the State of Texas:

5. For all discharges proposed for authorization under all NWPs, into the area of Caddo Lake within Texas that is designated as a “Wetland of International Importance” under the Ramsar Convention, the applicant shall notify the Fort Worth District Engineer in accordance with the NWP General Condition 31. The Corps will coordinate with the resource agencies as specified in NWP General Condition 31(d) (Pre-Construction Notification).

6. For all discharges proposed for authorization under NWP 43 that occur in forested wetlands, the applicant shall notify the Fort Worth District Engineer in accordance with the General Condition 31 (Pre-Construction Notification).

7. For all discharges proposed for authorization under any nationwide permit in Dallas, Denton, and Tarrant Counties that are within the study area of the "Final Regional Environmental Impact Statement (EIS), Trinity River and Tributaries" (May 1986), the applicant shall meet the criteria and follow the guidelines specified in Section III of the Record of Decision for the Regional EIS, including the hydraulic impact requirements. A copy of these guidelines is available upon request from the Fort Worth District and at the District website www.swf.usace.army.mil (select "Permits").

8. Federal Projects. The applicant shall notify the Forth Worth District Engineer in accordance with the NWP General Condition 31, Pre-Construction Notification (PCN) for any regulated activity where the applicant is proposing work that would result in the modification or alteration of any completed Corps of Engineer projects that are either locally or federally maintained and for work that would occur within the conservation pool or flowage easement of any Corps of Engineers lake project. PCN's cannot be deemed complete until such time as the Corps has made a determination relative to 33 USC Section 408, 33 CFR Part 208, Section 208.10, 33 CFR Part 320, Section 320.4.

9. Invasive and Exotic Species. Best management practices are required where practicable to reduce the risk of transferring invasive plant and animal species to or from project sites. Information concerning state specific lists and threats can be found at: http://www.invasivespeciesinfo.gov/unitedstates/tx.shtml. Best management practices can be found at: http://www.invasivespeciesinfo.gov/toolkit/prevention.shtml. Known zebra mussel waters within can be found at: http://nas.er.usgs.gov/queries/zmbyst.asp.

10. For all discharges proposed for authorization under NWPs 51 and 52, the Corps will provide the PCN to the US Fish and Wildlife Service as specified in NWP General Condition 31(d)(2) for its review and comments.

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

April 5, 2012

Ms. Kristi N. McMillan
Galveston District CESWG-PE-RE
U.S. Army Corps of Engineers
P.O. Box 1229
Galveston, Texas 77553-1229

Re: USACE Nationwide Permits

Dear Ms. McMillan:

This letter is in response to your January 23, 2012, letter requesting Clean Water Act Section 401 certification of the United States Army Corps of Engineers (Corps) Nationwide Permits (NWPs). The Final Notice of Reissuance of Nationwide Permits was published in the Federal Register (Vol. 77, No. 34, pages 10184-10290) on February 21, 2012. Proposed regional conditions for NWPs in Texas were proposed in public notices on February 24, 2011 and November 14, 2011.

The Texas Commission on Environmental Quality (TCEQ) has reviewed the Final Notice of Reissuance of Nationwide Permits and the proposed regional conditions. On behalf of the Executive Director and based on our evaluation of the information contained in these documents, the TCEQ certifies that the activities authorized by NWPs 1, 2, 4, 5, 8, 9, 10, 11, 20, 23, 24, 28, 34, 35, and 48 should not result in a violation of established Texas Surface Water Quality Standards as required by Section 401 of the Federal Clean Water Act and pursuant to Title 30, Texas Administrative Code, Chapter 279.

The TCEQ conditionally certifies that the activities authorized by NWPs 3, 6, 7, 12, 13, 14, 15, 17, 18, 19, 21, 22, 25, 27, 29, 30, 31, 32, 33, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 49, 50, 51 and 52 should not result in a violation of established Texas Surface Water Quality Standards as required by Section 401 of the Federal Clean Water Act and pursuant to Title 30, Texas Administrative Code, Chapter 279. Conditions for each NWP are defined in Enclosure 1 and more detail on specific conditions are discussed below.

The TCEQ understands that a prohibition against the use of NWPs in coastal dune swales will be included in the 2012 Texas Regional Conditions (Regional Conditions) for all NWPs, except for NWP 3. Inclusion of a prohibition of using NWPs in coastal dune swales, except for NWP 3, is a condition of this 401 TCEQ certification.

The TCEQ wants to clarify the application of NWP 16 in Texas. NWP 16 should be limited to the return water from upland contained dredged material disposal areas. It is important to emphasize the intent for dredged material disposal. The TCEQ understands dredged material to be associated with navigational dredging activities, not commercial mining activities. To avoid confusion the TCEQ requests that a regional condition be added that prohibits the use of NWP 16 for activities that would be regulated under Standard Industrial Classification (SIC) codes 1442 and 1446 (industrial and construction sand and gravel mining). This condition is also included as part of the 401 certification of NWP 16.

The final NWP 16 states that the quality of the return water is controlled by the state through the 401 certification procedures. Consistent with previous NWPs certification decisions the TCEQ is conditionally certifying NWP 16 for the return water from confined upland disposal not to exceed a 300 mg/L Total Suspended Solids (TSS) concentration and request the Corps to include this condition in the Regional Conditions. The TCEQ recognizes the usefulness of having an instantaneous method to determine compliance with the 300 mg/L TSS limit. However, existing literature and analysis of paired samples of turbidity and TSS from the Texas Surface Water Quality Data indicate this relationship must be a site specific characterization of the actual sediments to be dredged. To address this approach we have continued language in the NWP 16 conditional certification that allows flexibility to use an instantaneous method in implementing the TSS limit when a site specific correlation curve for turbidity (nephelometric turbidity units (NTU)) versus TSS has been approved by TCEQ. The TCEQ remains interested in working with the Corps in the development of these curves. We encourage the Corps to accept the conditional certification of NWP 16 as a Regional Condition and that we work together to find the best methods to implement this limit.

In evaluating this condition for the Regional Conditions for NWPs, the TCEQ encourages the Corps to consider that TSS limits are promulgated as effluent limits under Title 40 of the Code of Federal Regulations. The TCEQ requirement to control return water from confined upland disposal not to exceed a 300 mg/L TSS has also been included in individual 404 permits. It is also important to note that the TCEQ effectively imposes TSS effluent limits in thousands of wastewater discharge permits issued in Texas under Section 402 of the federal Clean Water Act.

The TCEQ is conditionally certifying NWP General Condition #12 *Soil Erosion and Sediment Controls*, and General Condition #25 *Water Quality*. The conditions address three broad categories of water quality management with specific recommendations for Best Management Practices (BMPs) for each category. These BMPs are intended to enhance the water quality protection of these General Conditions. A list of TCEQ-recommended BMPs is included as Enclosure 2.

Enclosure 3 is provided as a quick reference table for all NWPs. A detailed description of the BMPs is provided in Enclosure 4. Runoff from bridge decks has been exempted from the requirement for post-construction total suspended solids (TSS) controls under General Condition 25. As stated in our April 11, 2011 and November 30, 2011 letters to the Corps, the TCEQ would like to include these BMPs for the protection of waters in the state specific to each NWP as part of the regional conditions for Texas.

The TCEQ is conditionally certifying NWPs 13, 29, 39, 40, 41, 42, 43, 44, 50, 51, and 52 to require the Corps to copy TCEQ on all written approvals of waivers for impacts to ephemeral, intermittent or perennial streams. The TCEQ is conditionally certifying NWP 36 to require the Corps to copy TCEQ on all written waivers for discharges greater than the 50 cubic yard limit or boat ramps greater than 20 feet in width. The TCEQ is also conditionally certifying General Condition 23 *Mitigation* to require the Corps to copy TCEQ on any written notification of a mitigation waiver. The TCEQ is requesting this information to fulfill its responsibility to ensure water of the state is appropriately protected by understanding the impact of waivers being granted in Texas.

This certification decision is limited to those activities under the jurisdiction of the TCEQ. For activities related to the production and exploration of oil and gas, a Texas Railroad Commission certification is required as provided in the Texas Water Code §26.131.

The TCEQ has reviewed the Notice of Reissuance of Nationwide Permits for consistency with the Texas Coastal Management Program (CMP) goals and policies in accordance with the CMP regulations {Title 31, Texas Administrative Code (TAC), Chapter (§)505.30} and has determined that the action is consistent with the applicable CMP goals and policies.

This certification was reviewed for consistency with the CMP's development in critical areas policy {31 TAC §501.23} and dredging and dredged material disposal and placement policy {31 TAC §501.25}. This certification complies with the CMP goals {31 TAC §501.12(1, 2, 3, 5)} applicable to these policies.

The TCEQ reserves the right to modify this certification if additional information identifies specific areas where significant impacts, including cumulative or secondary impacts, are occurring, and the use of these NWPs would be inappropriate.

No review of property rights, location of property lines, nor the distinction between public and private ownership has been made, and this certification may not be used in any way with regard to questions of ownership.

If you require further assistance, please contact Mr. John Trevino, Water Quality Assessment Section, Water Quality Division (MC-150), at (512) 239-4600.

Sincerely,

Charles W. Maguire
Water Quality Division Director
Texas Commission on Environmental Quality

CWM/JT/gg

Attachments

ccs: Mr. Stephen Brooks, Branch Chief, U.S. Army Corp of Engineers, Regulatory Branch, CESWF-PER-R, P.O. Box 17300, Fort Worth, Texas 76102-0300
Ms. Kate Zultner, Secretary, Coastal Coordination Council, P.O. Box 12873, Austin, Texas 78711-2873
Mr. Allan E. Steinle, Branch Chief, U.S. Army Corps of Engineers, Albuquerque District, 4101 Jefferson Plaza NE, Room 313, Albuquerque, New Mexico 87109-3435
Regulatory Branch Chief, U.S. Army Corps of Engineers, Regulatory Branch CESWT-PE-R, 1645 South 101st East Avenue, Tulsa, Oklahoma, 74128
Regulatory Branch Chief, U.S. Army Corps of Engineers, El Paso Regulatory Office, CESPA-OD-R-EP, P.O. Box 6096, Fort Bliss, Texas 79906-6096

Attachment 1

Attachment 1
Conditions of Section 401 Certification for Nationwide Permits and General Conditions

General Condition 12 (Soil Erosion and Sediment Controls)

Erosion control and sediment control BMPs described in Attachment 2 are required with the use of this general condition. If the applicant does not choose one of the BMPs listed in Attachment 2, an individual 401 certification is required.

General Condition 25 (Water Quality)

Post-construction total suspended solids (TSS) BMPs described in Attachment 2 are required with the use of this general condition. If the applicant does not choose one of the BMP's listed in Attachment 2, an individual 401 certification is required. Bridge deck runoff is exempt from this requirement.

General Condition 23 (Mitigation)

The U.S. Army Corps of Engineers will copy the TCEQ on all mitigation waivers sent to applicants.

NWPs 13, 29, 39, 40, 41, 42, 43, 44, 50, 51, 52

The U.S. Army Corps of Engineers will copy the TCEQ on all written approvals of waivers for impacts to ephemeral, intermittent or perennial streams.

All NWPs except for NWP 3

These NWPs are not authorized for use in coastal dune swales in Texas.

NWP 3 (Maintenance)

Soil Erosion and Sediment Controls under General Condition 12 are required.

NWP 6 (Survey Activities)

Soil Erosion and Sediment Controls under General Condition 12 are required.

NWP 7 (Outfall Structures and Associated Intake Structures)

Soil Erosion and Sediment Controls under General Condition 12 are required.

NWP 12 (Utility Line Activities)

Soil Erosion and Sediment Controls under General Condition 12 are required. Post-construction TSS controls under General Condition 25 are required.

NWP 13 (Bank Stabilization)

Soil Erosion and Sediment Controls under General Condition 12 are required.

NWP 14 (Linear Transportation Projects)

Soil Erosion and Sediment Controls under General Condition 12 are required. Post-construction TSS controls under General Condition 25 are required.

NWP 15 (U.S. Coast Guard Approved Bridges)

Soil Erosion and Sediment Controls under General Condition 12 are required.

NWP 16 (Return Water From Upland Contained Disposal Areas)

Activities that would be regulated under Standard Industrial Classification (SIC) codes 1442 and 1446 (industrial and construction sand and gravel mining) are not eligible for this NWP. Effluent from an upland contained disposal area shall not exceed a TSS concentration of 300 mg/L unless a site-specific TSS limit, or a site specific correlation curve for turbidity (nephelometric turbidity units (NTU)) versus (TSS) has been approved by TCEQ.

NWP 17 (Hydropower Projects)

Soil Erosion and Sediment Controls under General Condition 12 are required. Post-construction TSS controls under General Condition 25 are required.

NWP 18 (Minor Discharges)

Soil Erosion and Sediment Controls under General Condition 12 are required. Post-construction TSS controls under General Condition 25 are required.

NWP 19 (Minor Dredging)

Soil Erosion and Sediment Controls under General Condition 12 are required.

NWP 21 (Surface Coal Mining Operations)

Soil Erosion and Sediment Controls under General Condition 12 are required. Post-construction TSS controls under General Condition 25 are required.

NWP 22 (Removal of Vessels)

Soil Erosion and Sediment Controls under General Condition 12 are required.

NWP 25 (Structural Discharges)

Soil Erosion and Sediment Controls under General Condition 12 are required.

NWP 27 (Aquatic Habitat Restoration, Establishment, and Enhancement Activities)

Soil Erosion and Sediment Controls under General Condition 12 are required.

NWP 29 (Residential Developments)

Soil Erosion and Sediment Controls under General Condition 12 are required. Post-construction TSS controls under General Condition 25 are required.

NWP 30 (Moist Soil Management for Wildlife)

Soil Erosion and Sediment Controls under General Condition 12 are required.

NWP 31 (Maintenance of Existing Flood Control Facilities)

Soil Erosion and Sediment Controls under General Condition 12 are required. Post-construction TSS controls under General Condition 25 are required.

NWP 32 (Completed Enforcement Actions)

Soil Erosion and Sediment Controls under General Condition 12 are required.

NWP 33 (Temporary Construction, Access and Dewatering)

Soil Erosion and Sediment Controls under General Condition 12 are required.

NWP 36 (Boat Ramps)

The U.S. Army Corps of Engineers will copy the TCEQ on all written waivers for discharges greater than the 50 cubic yard limit or boat ramps greater than 20 feet in width. Soil Erosion and Sediment Controls under General Condition 12 are required. Post-construction TSS controls under General Condition 25 are required.

NWP 37 (Emergency Watershed Protection and Rehabilitation)

Soil Erosion and Sediment Controls under General Condition 12 are required.

NWP 38 (Cleanup of Hazardous and Toxic Waste)

Soil Erosion and Sediment Controls under General Condition 12 are required.

NWP 39 (Commercial and Institutional Developments)

Soil Erosion and Sediment Controls under General Condition 12 are required. Post-construction TSS controls under General Condition 25 are required.

NWP 40 (Agricultural Activities)

Soil Erosion and Sediment Controls under General Condition 12 are required. Post-construction TSS controls under General Condition 25 are required.

NWP 41 (Reshaping Existing Drainage Ditches)

Soil Erosion and Sediment Controls under General Condition 12 are required. Post-construction TSS controls under General Condition 25 are required.

NWP 42 (Recreational Facilities)

Soil Erosion and Sediment Controls under General Condition 12 are required. Post-construction TSS controls under General Condition 25 are required.

NWP 43 (Stormwater Management Facilities)

Soil Erosion and Sediment Controls under General Condition 12 are required.

NWP 44 (Mining Activities)

Soil Erosion and Sediment Controls under General Condition 12 are required. Post-construction TSS controls under General Condition 25 are required.

NWP 45 (Repair of Uplands Damaged by Discrete Events)

Soil Erosion and Sediment Controls under General Condition 12 are required. Post-construction TSS controls under General Condition 25 are required.

NWP 46 (Discharges in Ditches)

Soil Erosion and Sediment Controls under General Condition 12 are required.

NWP 49 (Coal Remining Activities)

Soil Erosion and Sediment Controls under General Condition 12 are required. Post-construction TSS controls under General Condition 25 are required.

NWP 50 (Underground Coal Mining Activities)

Soil Erosion and Sediment Controls under General Condition 12 are required. Post-construction TSS controls under General Condition 25 are required.

NWP 51 (Land-Based Renewal Energy Generation Facilities)

Soil Erosion and Sediment Controls under General Condition 12 are required. Post-construction TSS controls under General Condition 25 are required.

NWP 52 (Water-Based Renewal Energy Generation Pilot Projects)

Soil Erosion and Sediment Controls under General Condition 12 are required. Post-construction TSS controls under General Condition 25 are required.

Attachment 2

Attaehment 2
401 Water Quality Certification Best Management Practices (BMPs) for Nationwide Permits

Below are the 401 water quality certification conditions the Texas Commission on Environmental Quality (TCEQ) added to the February 21, 2012 issuance of Nationwide Permits (NWP), as described in the Federal Register (Vol. 77, No. 34, pages 10184-10290).

Additional information regarding these conditions, including descriptions of the best management practices (BMPs), can be obtained from the TCEQ by contacting the 401 Coordinator, MC-150, P.O. Box 13087, Austin, Texas 78711-3087 or from the appropriate U.S. Army Corps of Engineers district office.

I. Erosion Control

Disturbed areas must be stabilized to prevent the introduction of sediment to adjacent wetlands or water bodies during wet weather conditions (erosion). *At least one* of the following BMPs must be maintained and remain in place until the area has been stabilized for NWPs 3, 6, 7, 12, 13, 14, 15, 17, 18, 19, 21, 22, 25, 27, 29, 30, 31, 32, 33, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 49, 50, 51, and 52. If the applicant does not choose one of the BMPs listed, an individual 401 certification is required. BMPs for NWP 52 apply only to land-based impacts from attendant features.

- o Temporary Vegetation
- o Blankets/Matting
- o Mulch
- o Sod
- o Interceptor Swale
- o Diversion Dike
- o Erosion Control Compost
- o Mulch Filter Socks
- o Compost Filter Socks

II. Scdimentation Control

Prior to project initiation, the project area must be isolated from adjaccnt wetlands and water bodies by the use of BMPs to confine sediment. Dredged material shall be placed in such a manner that prevents sediment runoff into water in the state, including wetlands. Water bodies can be isolated by the use of one or more of the required BMPs identified for sedimentation control. These BMP's must be maintained and remain in place until the dredged material is stabilized. *At least one* of the following BMPs must be maintained and remain in place until the area has been stabilized for NWPs 3, 6, 7, 12, 13, 14, 15, 17, 18, 19, 21, 22, 25, 27, 29, 30, 31, 32, 33, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 49, 50, 51, and 52. If the applicant does not choose one of the BMPs listed, an individual 401 certification is required. BMPs for NWP 52 apply only to land-based impacts from attendant features.

- o Sand Bag Berm
- o Rock Berm
- o Silt Fence
- o Hay Bale Dike
- o Triangular Filter Dike
- o Brush Berms

- o Stone Outlet Sediment Traps
- o Sediment Basins
- o Erosion Control Compost
- o Mulch Filter Socks
- o Compost Filter Socks

III. Post-Construction TSS Control

After construction has been completed and the site is stabilized, total suspended solids (TSS) loadings shall be controlled by *at least one* of the following BMPs for NWPs 12, 14, 17, 18, 21, 29, 31, 36, 39, 40, 41, 42, 44, 45, 49, 50, 51, and 52. If the applicant does not choose one of the BMPs listed, an individual 401 certification is required. BMPs for NWP 52 apply only to land-based impacts from attendant features. Runoff from bridge decks has been exempted from the requirement for post construction TSS controls.

- o Retention/Irrigation Systems
- o Constructed Wetlands
- o Extended Detention Basin
- o Wet Basins
- o Vegetative Filter Strips
- o Vegetation lined drainage ditches
- o Grassy Swales
- o Sand Filter Systems
- o Erosion Control Compost
- o Mulch Filter Socks
- o Compost Filter Socks
- o Sedimentation Chambers*

* Only to be used when there is no space available for other approved BMPs.

IV. NWP 16: Return Water from Upland Contained Disposal Areas

Effluent from an upland contained disposal area shall not exceed a TSS concentration of 300 mg/L unless a site-specific TSS limit, or a site specific correlation curve for turbidity (nephelometric turbidity units (NTU)) versus (TSS) has been approved by TCEQ.

V. NWP 29, 39, 40, 42, 43, 44, 50, 51, and 52

The Corps will copy the TCEQ on all authorizations for impacts of greater than 300 linear feet of intermittent and ephemeral streams.

Attachment 2
401 Water Quality Certification Best Management Practices (BMPs) for Nationwide Permits

VI. NWP 13 and 41

The Corps will copy the TCEQ on all authorizations for impacts greater than 500 linear feet in length of ephemeral, intermittent, perennial streams or drainage ditches.

VII. NWP 36

The Corps will copy the TCEQ on all authorizations for discharges greater than the 50 cubic yard limit or boat ramps greater than 20 feet in width.

VIII. All NWPs except NWP 3

These NWPs are not authorized for use in coastal dune swales in Texas.

Attachment 3

Attachment 3
Reference to Nationwide Permits Best Management Practices Requirements

NWP	Permit Description	Erosion Control	Sediment Control	Post Construction TSS
1	Aid to Navigation			
2	Structures in Artificial Canals			
3	Maintenance	X	X	
4	Fish and Wildlife Harvesting, Enhancement and Attraction Devices and Activities			
5	Scientific Measurement Devices			
6	Survey Activities *Trenching	X	X	
7	Outfall Structures and Associated Intake Structures	X	X	
8	Oil and Gas Structures on the Outer Continental Shelf			
9	Structures in Fleeting and Anchorage Areas			
10	Mooring Buoys			
11	Temporary Recreational Structures			
12	Utility Line Activities	X	X	X
13	Bank Stabilization	X	X	
14	Linear Transportation Projects	X	X	X
15	U.S. Coast Guard Approved Bridges	X	X	
16	Return Water From Upland Contained Disposal Areas			
17	Hydropower Projects	X	X	X
18	Minor Discharges	X	X	X
19	Minor Dredging	X	X	
20	Response Operations for Oil and Hazardous Substances			
21	Surface Coal Mining Operations	X	X	X
22	Removal of Vessels	X	X	
23	Approved Categorical Exclusions			

Attachment 3
Reference to Nationwide Permits Best Management Practices Requirements

NWP	Permit Description	Erosion Control	Sediment Control	Post Construction TSS
24	Indian Tribe or State Administered Section 404 Programs			
25	Structural Discharges	X	X	
26	[Reserved]			
27	Aquatic Habitat Restoration, Establishment, and Enhancement Activities	X	X	
28	Modifications of Existing Marinas			
29	Residential Developments	X	X	X
30	Moist Soil Management for Wildlife	X	X	
31	Maintenance of Existing Flood Control Facilities	X	X	X
32	Completed Enforcement Actions	X	X	
33	Temporary Construction, Access and Dewatering	X	X	
34	Cranberry Production Activities			
35	Maintenance Dredging of Existing Basins			
36	Boat Ramps	X	X	X
37	Emergency Watershed Protection and Rehabilitation	X	X	
38	Cleanup of Hazardous and Toxic Waste	X	X	
39	Commercial and Institutional Developments	X	X	X
40	Agricultural Activities	X	X	X
41	Reshaping Existing Drainage Ditches	X	X	X
42	Recreational Facilities	X	X	X
43	Stormwater Management Facilities	X	X	
44	Mining Activities	X	X	X
45.	Repair of Uplands Damaged by Discrete Events	X	X	X
46.	Discharges in Ditches	X	X	

Attachment 3
Reference to Nationwide Permits Best Management Practices Requirements

NWP	Permit Description	Erosion Control	Sediment Control	Post Construction TSS
47.	[Reserved]			
48.	Existing Commercial Shellfish Aquaculture Activities			
49.	Coal Remining Activities	X	X	X
50.	Underground Coal Mining Activities	X	X	X
51.	Land-Based Renewable Energy Generation Facilities	X	X	X
52.	Water-Based Renewable Energy Generation Pilot Projects	X	X	X

Attachment 4

Attachment 4
Description of BMPs

EROSION CONTROL BMPs

Temporary Vegetation

Description: Vegetation can be used as a temporary or permanent stabilization technique for areas disturbed by construction. Vegetation effectively reduces erosion in swales, stockpiles, berms, mild to medium slopes, and along roadways. Other techniques such as matting, mulches, and grading may be required to assist in the establishment of vegetation.

Materials:

- The type of temporary vegetation used on a site is a function of the season and the availability of water for irrigation.
- Temporary vegetation should be selected appropriately for the area.
- County agricultural extension agents are a good source for suggestions for temporary vegetation.
- All seed should be high quality, U.S. Dept. of Agriculture certified seed.

Installation:

- Grading must be completed prior to seeding.
- Slopes should be minimized.
- Erosion control structures should be installed.
- Seedbeds should be well pulverized, loose, and uniform.
- Fertilizers should be applied at appropriate rates.
- Seeding rates should be applied as recommended by the county agricultural extension agent.
- The seed should be applied uniformly.
- Steep slopes should be covered with appropriate soil stabilization matting.

Blankets and Matting

Description: Blankets and matting material can be used as an aid to control erosion on critical sites during the establishment period of protective vegetation. The most common uses are in channels, interceptor swales, diversion dikes, short, steep slopes, and on tidal or stream banks.
Materials:

New types of blankets and matting materials are continuously being developed. The Texas

Attachment 4
Description of BMPs

Department of Transportation (TxDOT) has defined the critical performance factors for these types of products and has established minimum performance standards which must be met for any product seeking to be approved for use within any of TxDOT's construction or maintenance activities. The products that have been approved by TxDOT are also appropriate for general construction site stabilization. TxDOT maintains a web site at http://www.txdot.gov/business/doing_business/product_evaluation/erosion_control.htm which is updated as new products are evaluated.

Installation:

- Install in accordance with the manufacturer's recommendations.
- Proper anchoring of the material.
- Prepare a friable seed bed relatively free from clods and rocks and any foreign material.
- Fertilize and seed in accordance with seeding or other type of planting plan.
- Erosion stops should extend beyond the channel liner to full design cross-section of the channel.
- A uniform trench perpendicular to line of flow may be dug with a spade or a mechanical trencher.
- Erosion stops should be deep enough to penetrate solid material or below level of ruling in sandy soils.
- Erosion stop mats should be wide enough to allow turnover at bottom of trench for stapling, while maintaining the top edge flush with channel surface.

Mulch

Description: Mulching is the process of applying a material to the exposed soil surface to protect it from erosive forces and to conserve soil moisture until plants can become established. When seeding critical sites, sites with adverse soil conditions or seeding on other than optimum seeding dates, mulch material should be applied immediately after seeding. Seeding during optimum seeding dates and with favorable soils and site conditions will not need to be mulched.

Materials:

- Mulch may be small grain straw which should be applied uniformly.
- On slopes 15 percent or greater, a binding chemical must be applied to the surface.
- Wood-fiber or paper-fiber mulch may be applied by hydroseeding.
- Mulch nettings may be used.

- Wood chips may be used where appropriate.

Installation:

Mulch anchoring should be accomplished immediately after mulch placement. This may be done by one of the following methods: peg and twine, mulch netting, mulch anchoring tool, or liquid mulch binders.

Sod

Description: Sod is appropriate for disturbed areas which require immediate vegetative covers, or where sodding is preferred to other means of grass establishment. Locations particularly suited to stabilization with sod are waterways carrying intermittent flow, areas around drop inlets or in grassed swales, and residential or commercial lawns where quick use or aesthetics are factors. Sod is composed of living plants and those plants must receive adequate care in order to provide vegetative stabilization on a disturbed area.

Materials:

- Sod should be machine cut at a uniform soil thickness.
- Pieces of sod should be cut to the supplier's standard width and length.
- Torn or uneven pads are not acceptable.
- Sections of sod should be strong enough to support their own weight and retain their size and shape when suspended from a firm grasp.
- Sod should be harvested, delivered, and installed within a period of 36 hours.

Installation:

- Areas to be sodded should be brought to final grade.
- The surface should be cleared of all trash and debris.
- Fertilize according to soil tests.
- Fertilizer should be worked into the soil.
- Sod should not be cut or laid in excessively wet or dry weather.
- Sod should not be laid on soil surfaces that are frozen.
- During periods of high temperature, the soil should be lightly irrigated.

- The first row of sod should be laid in a straight line with subsequent rows placed parallel to and butting tightly against each other.
- Lateral joints should be staggered to promote more uniform growth and strength.
- Wherever erosion may be a problem, sod should be laid with staggered joints and secured.
- Sod should be installed with the length perpendicular to the slope (on the contour).
- Sod should be rolled or tamped.
- Sod should be irrigated to a sufficient depth.
- Watering should be performed as often as necessary to maintain soil moisture.
- The first mowing should not be attempted until the sod is firmly rooted.
- Not more than one third of the grass leaf should be removed at any one cutting.

Interceptor Swale

Interceptor swales are used to shorten the length of exposed slope by intercepting runoff, prevent off-site runoff from entering the disturbed area, and prevent sediment-laden runoff from leaving a disturbed site. They may have a v-shape or be trapezoidal with a flat bottom and side slopes of 3:1 or flatter. The outflow from a swale should be directed to a stabilized outlet or sediment trapping device. The swales should remain in place until the disturbed area is permanently stabilized.

Materials:

- Stabilization should consist of a layer of crushed stone three inches thick, riprap or high velocity erosion control mats.
- Stone stabilization should be used when grades exceed 2% or velocities exceed 6 feet per second.
- Stabilization should extend across the bottom of the swale and up both sides of the channel to a minimum height of three inches above the design water surface elevation based on a 2-year, 24-hour storm.

Installation:

- An interceptor swale should be installed across exposed slopes during construction and should intercept no more than 5 acres of runoff.
- All earth removed and not needed in construction should be disposed of in an approved spoils site so that it will not interfere with the functioning of the swale or contribute to siltation in other areas of the site.

- All trees, brush, stumps, obstructions and other material should be removed and disposed of so as not to interfere with the proper functioning of the swale.

- Swales should have a maximum depth of 1.5 feet with side slopes of 3:1 or flatter. Swales should have positive drainage for the entire length to an outlet.

- When the slope exceeds 2 percent, or velocities exceed 6 feet per second (regardless of slope), stabilization is required. Stabilization should be crushed stone placed in a layer of at least 3 inches thick or may be high velocity erosion control matting. Check dams are also recommended to reduce velocities in the swales possibly reducing the amount of stabilization necessary.

- Minimum compaction for the swale should be 90% standard proctor density.

Diversion Dikes

A temporary diversion dike is a barrier created by the placement of an earthen embankment to reroute the flow of runoff to an erosion control device or away from an open, easily erodible area. A diversion dike intercepts runoff from small upland areas and diverts it away from exposed slopes to a stabilized outlet, such as a rock berm, sandbag berm, or stone outlet structure. These controls can be used on the perimeter of the site to prevent runoff from entering the construction area. Dikes are generally used for the duration of construction to intercept and reroute runoff from disturbed areas to prevent excessive erosion until permanent drainage features are installed and/or slopes are stabilized.

Materials:

- Stone stabilization (required for velocities in excess of 6 fps) should consist of riprap placed in a layer at least 3 inches thick and should extend a minimum height of 3 inches above the design water surface up the existing slope and the upstream face of the dike.

- Geotextile fabric should be a non-woven polypropylene fabric designed specifically for use as a soil filtration media with an approximate weight of 6 oz./yd^2, a Mullen burst rating of 140 psi, and having an equivalent opening size (EOS) greater than a #50 sieve.

Installation:

- Diversion dikes should be installed prior to and maintained for the duration of construction and should intercept no more than 10 acres of runoff.

- Dikes should have a minimum top width of 2 feet and a minimum height of compacted fill of 18 inches measured form the top of the existing ground at the upslopc toe to top of the dike and have side slopes of 3:1 or flatter.

- The soil for the dike should be placed in lifts of 8 inches or less and be compacted to 95 % standard proctor density.

- The channel, which is formed by the dike, must have positive drainage for its entire length to an outlet.

- When the slope exceeds 2 percent, or velocities exceed 6 feet per second (regardless of slope), stabilization is required. In situations where velocities do not exceed 6 feet per second, vegetation may be used to control erosion.

Erosion Control Compost

Description: Erosion control compost (ECC) can be used as an aid to control erosion on critical sites during the establishment period of protective vegetation. The most common uses are on steep slopes, swales, diversion dikes, and on tidal or stream banks.

Materials:

New types of erosion control compost are continuously being developed. The Texas Department of Transportation (TxDOT) has established minimum performance standards which must be met for any products seeking to be approved for use within any of TxDOT's construction or maintenance activities. Material used within any TxDOT construction or maintenance activities must meet material specifications in accordance with current TxDOT specifications. TxDOT maintains a website at http://www.txdot.gov/business/contractors_consultants/recycling/compost.htm that provides information on compost specification data.

ECC used for projects not related to TxDOT should also be of quality materials by meeting performance standards and compost specification data. To ensure the quality of compost used as an ECC, products should meet all applicable state and federal regulations, including but not limited to the United States Environmental Protection Agency (USEPA) Code of Federal Regulations (CFR), Title 40, Part 503 Standards for Class A biosolids and Texas Natural Resource Conservation Commission (now named TCEQ) Health and Safety Regulations as defined in the Texas Administration Code (TAC), Chapter 332, and all other relevant requirements for compost products outlined in TAC, Chapter 332. Testing requirements required by the TCEQ are defined in TAC Chapter 332, including Sections §332.71 Sampling and Analysis Requirements for Final Products and §332.72 Final Product Grades. Compost specification data approved by TxDOT are appropriate to use for ensuring the use of quality compost materials or for guidance.

Testing standards are dependent upon the intended use for the compost and ensures product safety, and product performance regarding the product's specific use. The appropriate compost sampling and testing protocols included in the United States Composting Council (USCC) Test Methods for the Examination of Composting and Compost (TMECC) should be conducted on compost products used for ECC to ensure that the products used will not impact public health, safety, and the environment and to promote production and marketing of quality composts that meet analytical standards. TMECC is a laboratory manual that provides protocols for the composting industry and test methods for compost analysis. TMECC provides protocols to sample, monitor, and analyze materials during all stages of the composting proccss. Numerous parameters that might be of concern in compost can be tested by following protocols or test methods listed in TMECC. TMECC information can be found at http://www.tmecc.org/tmecc/index.html. The USCC Seal of Testing Assurance (STA) program contains information regarding compost STA certification. STA program information can be found at http://tmecc.org/sta/STA_program_description.html.

Attachment 4
Description of BMPs

Installation:

- Install in accordance with current TxDOT specification.
- Use on slopes 3:1 or flatter.
- Apply a 2 inch uniform layer unless otherwise shown on the plans or as directed.
- When rolling is specified, use a light corrugated drum roller.

Mulch and Compost Filter Socks

Description: Mulch and compost filter socks (erosion control logs) are used to intercept and detain sediment laden run-off from unprotected areas. When properly used, mulch and compost filter socks can be highly effective at controlling sediment from disturbed areas. They cause runoff to pond which allows heavier solids to settle. Mulch and compost filter socks are used during the period of construction near the perimeter of a disturbed area to intercept sediment while allowing water to percolate through. The sock should remain in place until the area is permanently stabilized. Mulch and compost filter socks may be installed in construction areas and temporarily moved during the day to allow construction activity provided it is replaced and properly anchored at the end of the day. Mulch and compost filter socks may be seeded to allow for quick vegetative growth and reduction in run-off velocity.

Materials:

New types of mulch and compost filter socks are continuously being developed. The Texas Department of Transportation (TxDOT) has established minimum performance standards which must be met for any products seeking to be approved for use within any of TxDOT's construction or maintenance activities. Mulch and compost filter socks used within any TxDOT construction or maintenance activities must meet material specifications in accordance with TxDOT specification 5049. TxDOT maintains a website at http://www.txdot.gov/business/contractors_consultants/recycling/compost.htm that provides information on compost specification data.

Mulch and compost filter socks used for projects not related to TxDOT should also be of quality materials by meeting performance standards and compost specification data. To ensure the quality of compost used for mulch and compost filter socks, products should meet all applicable state and federal regulations, including but not limited to the United States Environmental Protection Agency (USEPA) Code of Federal Regulations (CFR), Title 40, Part 503 Standards for Class A biosolids and Texas Natural Resource Conservation Commission Health and Safety Regulations as defined in the Texas Administration Code (TAC), Chapter 332, and all other relevant requirements for compost products outlined in TAC, Chapter 332. Testing requirements required by the TCEQ are defined in TAC Chapter 332, including Sections §332.71 Sampling and Analysis Requirements for Final Products and §332.72 Final Product Grades. Compost specification data approved by TxDOT are appropriate to use for ensuring the use of quality compost materials or for guidance.

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Installation:

- Install in accordance with TxDOT Special Specification 5049.
- Install socks (erosion control logs) near the downstream perimeter of a disturbed area to intercept sediment from sheet flow.
- Secure socks in a method adequate to prevent displacement as a result of normal rain events such that flow is not allowed under the socks.
- Inspect and maintain the socks in good condition (including staking, anchoring, etc.). Maintain the integrity of the control, including keeping the socks free of accumulated silt, debris, etc., until the disturbed area has been adequately stabilized.

SEDIMENT CONTROL BMPS

Sand Bag Berm

Description: The purpose of a sandbag berm is to dctain sediment carried in runoff from disturbed areas. This objective is accomplished by intercepting runoff and causing it to pool behind the sand bag berm. Sediment carried in the runoff is deposited on the upstream side of the sand bag berm due to the rcduced flow velocity. Excess runoff volumes are allowed to flow over the top of the sand bag berm. Sand bag berms are used only during construction activities in streambeds when the contributing drainage area is between 5 and 10 acres and the slope is less than 15%, i.e., utility construction in channels, temporary channel crossing for construction equipment, etc. Plastic facing should be installed on the upstream side and the berm should be anchored to the streambed by drilling into the rock and driving in "T" posts or rebar (#5 or #6) spaced appropriately.

Attachment 4
Description of BMPs

Materials:

- The sand bag material should be polypropylene, polyethylene, polyamide or cotton burlap woven fabric, minimum unit weight 4 oz/yd 2, mullen burst strength exceeding 300 psi and ultraviolet stability exceeding 70 percent.

- The bag length should be 24 to 30 inches, width should be 16 to 18 inches and thickness should be 6 to 8 inches.

- Sandbags should be filled with coarse grade sand and free from deleterious material. All sand should pass through a No. 10 sieve. The filled bag should have an approximate weight of 40 pounds.

- Outlet pipe should be schedule 40 or stronger polyvinyl chloride (PVC) having a nominal internal diameter of 4 inches.

Installation:

- The berm should be a minimum height of 18 inches, measured from the top of the existing ground at the upslope toe to the top of the berm.

- The berm should be sized as shown in the plans but should have a minimum width of 48 inches measured at the bottom of the berm and 16 inches measured at the top of the berm.

- Runoff water should flow over the tops of the sandbags or through 4-inch diameter PVC pipes embedded below the top layer of bags.

- When a sandbag is filled with material, the open end of the sandbag should be stapled or tied with nylon or poly cord.

- Sandbags should be stacked in at least three rows abutting each other, and in staggered arrangement.

- The base of the berm should have at least 3 sandbags. These can be reduced to 2 and 1 bag in the second and third rows respectively.

- For each additional 6 inches of height, an additional sandbag must be added to each row width.

- A bypass pump-around system, or similar alternative, should be used on conjunction with the berm for effective dewatering of the work area.

Silt Fence

Description: A silt fence is a barrier consisting of geotextile fabric supported by metal posts to prevent soil and sediment loss from a site. When properly used, silt fences can be highly effective at controlling sediment from disturbed areas. They cause runoff to pond which allows heavier solids to settle. If not properly installed, silt fences are not likely to be effective. The purpose of a silt fence is to intercept and detain water-borne sediment from unprotected areas of a limited

extent. Silt fence is used during the period of construction near the perimeter of a disturbed area to intercept sediment while allowing water to percolate through. This fence should remain in place until the disturbed area is permanently stabilized. Silt fence should not be used where there is a concentration of water in a channel or drainage way. If concentrated flow occurs after installation, corrective action must be taken such as placing a rock berm in the areas of concentrated flow. Silt fencing within the site may be temporarily moved during the day to allow construction activity provided it is replaced and properly anchored to the ground at the end of the day. Silt fences on the perimeter of the site or around drainage ways should not be moved at any time.

Materials:

- Silt fence material should be polypropylene, polyethylene or polyamide woven or nonwoven fabric. The fabric width should be 36 inches, with a minimum unit weight of 4.5 oz/yd, mullen burst strength exceeding 190 lb/in 2, ultraviolet stability exceeding 70%, and minimum apparent opening size of U.S. Sieve No. 30.

- Fence posts should be made of hot rolled steel, at least 4 feet long with Tee or Y-bar cross section, surface painted or galvanized, minimum nominal weight 1.25 lb/ft 2, and Brindell hardness exceeding 140.

- Woven wire backing to support the fabric should be galvanized 2" x 4" welded wire, 12 gauge minimum.

Installation:

- Steel posts, which support the silt fence, should be installed on a slight angle toward the anticipated runoff source. Post must be embedded a minimum of 1 foot deep and spaced not more than 8 feet on center. Where water concentrates, the maximum spacing should be 6 feet.

- Lay out fencing down-slope of disturbed area, following the contour as closely as possible. The fence should be sited so that the maximum drainage area is ¼ acre/100 feet of fence.

- The toe of the silt fence should be trenched in with a spade or mechanical trencher, so that the down-slope face of the trench is flat and perpendicular to the line of flow. Where fence cannot be trenched in (e.g., pavement or rock outcrop), weight fabric flap with 3 inches of pea gravel on uphill side to prevent flow from seeping under fence.

- The trench must be a minimum of 6 inches deep and 6 inches wide to allow for the silt fence fabric to be laid in the ground and backfilled with compacted material.

- Silt fence should be securely fastened to each steel support post or to woven wire, which is in turn attached to the steel fence post. There should be a 3-foot overlap, securely fastened where ends of fabric meet.

Triangular Filter Dike

Description: The purpose of a triangular sediment filter dike is to intercept and detain water-

borne sediment from unprotected areas of limited extent. The triangular sediment filter dike is used where there is no concentration of water in a channel or other drainage way above the barrier and the contributing drainage area is less than one acre. If the uphill slope above the dike exceeds 10%, the length of the slope above the dike should be less than 50 feet. If concentrated flow occurs after installation, corrective action should be taken such as placing rock berm in the areas of concentrated flow. This measure is effective on paved areas where installation of silt fence is not possible or where vehicle access must be maintained. The advantage of these controls is the ease with which they can be moved to allow vehicle traffic and then reinstalled to maintain sediment

Materials:

- Silt fence material should be polypropylene, polyethylene or polyamide woven or nonwoven fabric. The fabric width should be 36 inches, with a minimum unit weight of 4.5 oz/yd, mullen burst strength exceeding 190 lb/in 2 , ultraviolet stability exceeding 70%, and minimum apparent opening size of U.S. Sieve No. 30.

- The dike structure should be 6 gauge 6" x 6" wire mesh folded into triangular form being eighteen (18) inches on each side.

Installation:

- The frame of the triangular sediment filter dike should be constructed of 6" x 6", 6 gauge welded wire mesh, 18 inches per side, and wrapped with geotextile fabric the same composition as that used for silt fences.

- Filter material should lap over ends six (6) inches to cover dike to dike junction; each junction should be secured by shoat rings.

- Position dike parallel to the contours, with the end of each section closely abutting the adjacent sections.

- There are several options for fastening the filter dike to the ground. The fabric skirt may be toed-in with 6 inches of compacted material, or 12 inches of the fabric skirt should extend uphill and be secured with a minimum of 3 inches of open graded rock, or with staples or nails. If these two options are not feasible the dike structure may be trenched in 4 inches.

- Triangular sediment filter dikes should be installed across exposed slopes during construction with ends of the dike tied into existing grades to prevent failure and should intercept no more than one acre of runoff.

- When moved to allow vehicular access, the dikes should be reinstalled as soon as possible, but always at the end of the workday.

Rock Berm

Description: The purpose of a rock berm is to serve as a check dam in areas of concentrated flow, to intercept sediment-laden runoff, detain the sediment and release the water in sheet flow.

The rock berm should be used when the contributing drainage area is less than 5 acres. Rock berms are used in areas where the volume of runoff is too great for a silt fence to contain. They are less effective for sediment removal than silt fences, particularly for fine particles, but are able to withstand higher flows than a silt fence. As such, rock berms are often used in areas of channel flows (ditches, gullies, etc.). Rock berms are most effective at reducing bed load in channels and should not be substituted for other erosion and sediment control measures further up the watershed.

Materials:

- The berm structure should be secured with a woven wire sheathing having maximum opening of 1 inch and a minimum wire diameter of 20 gauge galvanized and should be secured with shoat rings.

- Clean, open graded 3- to 5-inch diameter rock should be used, except in areas where high velocities or large volumes of flow are expected, where 5- to 8-inch diameter rocks may be used.

Installation:

- Lay out the woven wire sheathing perpendicular to the flow line. The sheathing should be 20 gauge woven wire mesh with 1 inch openings.

- Berm should have a top width of 2 feet minimum with side slopes being 2:1 (H:V) or flatter.

- Place the rock along the sheathing to a height not less than 18".

- Wrap the wire sheathing around the rock and secure with tie wire so that the ends of the sheathing overlap at least 2 inches, and the berm retains its shape when walked upon.

- Berm should be built along the contour at zero percent grade or as near as possible.

- The ends of the berm should be tied into existing upslope grade and the berm should be buried in a trench approximately 3 to 4 inches deep to prevent failure of the control.

Hay Bale Dike

Deseription: The purpose of a hay or straw bale dike is to intercept and detain small amounts of sediment-laden runoff from relatively small unprotected areas. Straw bales are to be used when it is not feasible to install other, more effective measures or when the construction phase is expected to last less than 3 months. Straw bales should not be used on areas where rock or other hard surfaces prevent the full and uniform anchoring of the barrier.

Materials:

Straw: The best quality straw mulch comes from wheat, oats or barley and should be free of weed and grass seed which may not be desired vegetation for the area to be protected. Straw mulch is light and therefore must be properly anchored to the ground.

Hay: This is very similar to straw with the exception that it is made of grasses and weeds and not grain stems. This form of mulch is very inexpensive and is widely available but does introduce weed and grass seed to the area. Like straw, hay is light and must be anchored.

- Straw bales should weigh a minimum of 50 pounds and should be at least 30 inches long.
- Bales should be composed entirely of vegetable matter and be free of seeds.
- Binding should be either wire or nylon string, jute or cotton binding is unacceptable. Bales should be used for not more than two months before being replaced.

Installation:

- Bales should be embedded a minimum of 4 inches and securely anchored using 2" x 2" wood stakes or 3/8" diameter rebar driven through the bales into the ground a minimum of 6 inches.
- Bales are to be placed directly adjacent to one another leaving no gap between them.
- All bales should be placed on the contour.
- The first stake in each bale should be angled toward the previously laid bale to force the bales together.

Brush Berms

Organic litter and spoil material from site clearing operations is usually burned or hauled away to be dumped elsewhere. Much of this material can be used effectively on the construction site itself. The key to constructing an efficient brush berm is in the method used to obtain and place the brush. It will not be acceptable to simply take a bulldozer and push whole trees into a pile. This method does not assure continuous ground contact with the berm and will allow uncontrolled flows under the berm.

Brush berms may be used where there is little or no concentration of water in a channel or other drainage way above the berm. The size of the drainage area should be no greater than one-fourth of an acre per 100 feet of barrier length; the maximum slope length behind the barrier should not exceed 100 feet; and the maximum slope gradient behind the barrier should be less than 50 percent (2:1).

Materials:

- The brush should consist of woody brush and branches, preferably less than 2 inches in diameter.
- The filter fabric should conform to the specifications for filter fence fabric.
- The rope should be ¼ inch polypropylene or nylon rope.

- The anchors should be 3/8-inch diameter rebar stakes that are 18-inches long.

Installation:

- Lay out the brush berm following the contour as closely as possible.
- The juniper limbs should be cut and hand placed with the vegetated part of the limb in close contact with the ground. Each subsequent branch should overlap the previous branch providing a shingle effect.
- The brush berm should be constructed in lifts with each layer extending the entire length of the berm before the next layer is started.
- A trench should be excavated 6-inches wide and 4-inches deep along the length of the barrier and immediately uphill from the barrier.
- The filter fabric should be cut into lengths sufficient to lay across the barrier from its up-slope base to just beyond its peak. The lengths of filter fabric should be draped across the width of the barrier with the uphill edge placed in the trench and the edges of adjacent pieces overlapping each other. Where joints are necessary, the fabric should be spliced together with a minimum 6-inch overlap and securely sealed.
- The trench should be backfilled and the soil compacted over the filter fabric.
- Set stakes into the ground along the downhill edge of the brush barrier, and anchor the fabric by tying rope from the fabric to the stakes. Drive the rope anchors into the ground at approximately a 45-degree angle to the ground on 6-foot centers.
- Fasten the rope to the anchors and tighten berm securely to the ground with a minimum tension of 50 pounds.
- The height of the brush berm should be a minimum of 24 inches after the securing ropes have been tightened.

Stone Outlet Sediment Traps

A stone outlet sediment trap is an impoundment created by the placement of an earthen and stone embankment to prevent soil and sediment loss from a site. The purpose of a sediment trap is to intercept sediment-laden runoff and trap the sediment in order to protect drainage ways, properties and rights of way below the sediment trap from sedimentation. A sediment trap is usually installed at points of discharge from disturbed areas. The drainage area for a sediment trap is recommended to be less than 5 acres.

Larger areas should be treated using a sediment basin. A sediment trap differs from a sediment basin mainly in the type of discharge structure. The trap should be located to obtain the maximum storage benefit from the terrain, for ease of clean out and disposal of the trapped

sediment and to minimize interference with construction activities. The volume of the trap should be at least 3600 cubic feet per acre of drainage area.

Materials:

- All aggregate should be at least 3 inches in diameter and should not exceed a volume of 0.5 cubic foot.
- The geotextile fabric specification should be woven polypropylene, polyethylene or polyamide geotextile, minimum unit weight of 4.5 oz/yd 2, mullen burst strength at least 250 lb/in 2, ultraviolet stability exceeding 70%, and equivalent opening size exceeding 40.

Installation:

- Earth Embankment: Place fill material in layers not more than 8 inches in loose depth. Before compaction, moisten or aerate each layer as necessary to provide the optimum moisture content of the material. Compact each layer to 95 percent standard proctor density. Do not place material on surfaces that are muddy or frozen. Side slopes for the embankment are to be 3:1. The minimum width of the embankment should be 3 feet.
- A gap is to be left in the embankment in the location where the natural confluence of runoff crosses the embankment line. The gap is to have a width in feet equal to 6 times the drainage area in acres.
- Geotextile Covered Rock Core: A core of filter stone having a minimum height of 1.5 feet and a minimum width at the base of 3 feet should be placed across the opening of the earth embankment and should be covered by geotextile fabric which should extend a minimum distance of 2 feet in either direction from the base of the filter stone core.
- Filter Stone Embankment: Filter stone should be placed over the geotextile and is to have a side slope which matches that of the earth embankment of 3:1 and should cover the geotextile/rock core a minimum of 6 inches when installation is complete. The crest of the outlet should be at least 1 foot below the top of the embankment.

Sediment Basins:

The purpose of a sediment basin is to intercept sediment-laden runoff and trap the sediment in order to protect drainage ways, properties and rights of way below the sediment basin from sedimentation. A sediment basin is usually installed at points of discharge from disturbed areas. The drainage area for a sediment basin is recommended to be less than 100 acres.

Sediment basins are effective for capturing and slowly releasing the runoff from larger disturbed areas thereby allowing sedimentation to take place. A sediment basin can be created where a permanent pond BMP is being constructed. Guidelines for construction of the permanent BMP should be followed, but revegetation, placement of underdrain piping, and installation of sand or other filter media should not be carried out until the site construction phase is complete.

Attachment 4
Description of BMPs

Materials:

- Riser should be corrugated metal or reinforced concrete pipe or box and should have watertight fittings or end to end connections of sections.
- An outlet pipe of corrugated metal or reinforced concrete should be attached to the riser and should have positive flow to a stabilized outlet on the downstream side of the embankment.
- An anti-vortex device and rubbish screen should be attached to the top of the riser and should be made of polyvinyl chloride or corrugated metal.

Basin Design and Construction:

- For common drainage locations that serve an area with ten or more acres disturbed at one time, a sediment basin should provide storage for a volume of runoff from a two-year, 24-hour storm from each disturbed acre drained.
- The basin length to width ratio should be at least 2:1 to improve trapping efficiency. The shape may be attained by excavation or the use of baffles. The lengths should be measured at the elevation of the riser de-watering hole.
- Place fill material in layers not more than 8 inches in loose depth. Before compaction, moisten or aerate each layer as necessary to provide the optimum moisture content of the material. Compact each layer to 95 percent standard proctor density. Do not place material on surfaces that are muddy or frozen. Side slopes for the embankment should be 3:1 (H:V).
- An emergency spillway should be installed adjacent to the embankment on undisturbed soil and should be sized to carry the full amount of flow generated by a 10-year, 3-hour storm with 1 foot of freeboard less the amount which can be carried by the principal outlet control device.
- The emergency spillway should be lined with riprap as should the swale leading from the spillway to the normal watercourse at the base of the embankment.
- The principal outlet control device should consist of a rigid vertically oriented pipe or box of corrugated metal or reinforced concrete. Attached to this structure should be a horizontal pipe, which should extend through the embankment to the toe of fill to provide a de-watering outlet for the basin.
- An anti-vortex device should be attached to the inlet portion of the principal outlet control device to serve as a rubbish screen.
- A concrete base should be used to anchor the principal outlet control device and should be sized to provide a safety factor of 1.5 (downward forces = 1.5 buoyant forces).
- The basin should include a permanent stake to indicate the sediment level in the pool and marked to indicate when the sediment occupies 50% of the basin volume (not the top of the

stake).

- The top of the riser pipe should remain open and be guarded with a trash rack and anti-vortex device. The top of the riser should be 12 inches below the elevation of the emergency spillway. The riser should be sized to convey the runoff from the 2-year, 3-hour storm when the water surface is at the emergency spillway elevation. For basins with no spillway the riser must be sized to convey the runoff from the 10-yr, 3-hour storm.

- Anti-seep collars should be included when soil conditions or length of service make piping through the backfill a possibility.

- The 48-hour drawdown time will be achieved by using a riser pipe perforated at the point measured from the bottom of the riser pipe equal to ½ the volume of the basin. This is the maximum sediment storage elevation. The size of the perforation may be calculated as follows:

$$Ao = \frac{As \times \sqrt{2h}}{Cd \times 980{,}000}$$

Where:
A_o = Area of the de-watering hole, ft 2
A_s = Surface area of the basin, ft 2
C_d = Coefficient of contraction, approximately 0.6
h = head of water above the hole, ft
Perforating the riser with multiple holes with a combined surface area equal to A_o is acceptable.

Erosion Control Compost

Description: Erosion control compost (ECC) can be used as an aid to control erosion on critical sites during the establishment period of protective vegetation. The most common uses are on steep slopes, swales, diversion dikes, and on tidal or stream banks.

Materials:

New types of erosion control compost are continuously being developed. The Texas Department of Transportation (TxDOT) has established minimum performance standards which must be met for any products seeking to be approved for use within any of TxDOT's construction or maintenance activities. Material used within any TxDOT construction or maintenance activities must meet material specifications in accordance with current TxDOT specifications. TxDOT maintains a website at http://www.txdot.gov/business/contractors_consultants/recycling/compost.htm that provides information on compost specification data.

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Installation:

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- Use on slopes 3:1 or flatter.
- Apply a 2 inch uniform layer unless otherwise shown on the plans or as directed.
- When rolling is specified, use a light corrugated drum roller.

Mulch and Compost Filter Socks

Description: Mulch and compost filter socks (erosion control logs) are used to intercept and detain sediment laden run-off from unprotected areas. When properly used, mulch and compost filter socks can be highly effective at controlling sediment from disturbed areas. They cause runoff to pond which allows heavier solids to settle. Mulch and compost filter socks are used during the period of construction near the perimeter of a disturbed area to intercept sediment while allowing water to percolate through. The sock should remain in place until the area is permanently stabilized. Mulch and compost filter socks may be installed in construction areas

and temporarily moved during the day to allow construction activity provided it is replaced and properly anchored at the end of the day. Mulch and compost filter socks may be seeded to allow for quick vegetative growth and reduction in run-off velocity.

Materials:

New types of mulch and compost filter socks are continuously being developed. The Texas Department of Transportation (TxDOT) has established minimum performance standards which must be met for any products seeking to be approved for use within any of TxDOT's construction or maintenance activities. Mulch and compost filter socks used within any TxDOT construction or maintenance activities must meet material specifications in accordance with TxDOT specification 5049. TxDOT maintains a website at http://www.txdot.gov/business/contractors_consultants/recycling/compost.htm that provides information on compost specification data.

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Installation:

- Install in accordance with TxDOT Special Specification 5049.

- Install socks (erosion control logs) near the downstream perimeter of a disturbed area to intercept sediment from sheet flow.
- Secure socks in a method adequate to prevent displacement as a result of normal rain events such that flow is not allowed under the socks.
- Inspect and maintain the socks in good condition (including staking, anchoring, etc.). Maintain the integrity of the control, including keeping the socks free of accumulated silt, debris, etc., until the disturbed area has been adequately stabilized.

POST-CONSTRUCTION TSS CONTROLS

Retention/Irrigation Systems

Deseription: Retention/irrigation systems refer to the capture of runoff in a holding pond, then use of the captured water for irrigation of appropriate landscape areas. Retention/irrigation systems are characterized by the capture and disposal of runoff without direct release of captured flow to receiving streams. Retention systems exhibit excellent pollutant removal but can require regular, proper maintenance. Collection of roof runoff for subsequent use (rainwater harvesting) also qualifies as a retention/irrigation practice, but should be operated and sized to provide adequate volume. This technology, which emphasizes beneficial use of stormwater runoff, is particularly appropriate for arid regions because of increasing demands on water supplies for agricultural irrigation and urban water supply.

Design Considerations: Retention/irrigation practices achieve 100% removal efficiency of total suspended solids contained within the volume of water captured. Design elements of retention/irrigation systems include runoff storage facility configuration and sizing, pump and wet well system components, basin lining, basin detention time, and physical and operational components of the irrigation system. Retention/irrigation systems are appropriate for large drainage areas with low to moderate slopes. The retention capacity should be sufficient considering the average rainfall event for the area.

Maintenance Requirements: Maintenance requirements for retention/irrigation systems include routine inspections, sediment removal, mowing, debris and litter removal, erosion control, and nuisance control.

Extended Detention Basin

Deseription: Extended detention facilities are basins that temporarily store a portion of stormwater runoff following a storm event. Extended detention basins are normally used to remove particulate pollutants and to reduce maximum runoff rates associated with development to their pre-development levels. The water quality benefits are the removal of sediment and buoyant materials. Furthermore, nutrients, heavy metals, toxic materials, and oxygen-demanding materials associated with the particles also are removed. The control of the maximum runoff rates serves to protect drainage channels below the device from erosion and to reduce downstream flooding. Although detention facilities designed for flood control have different design requirements than those used for water quality enhancement, it is possible to

achieve these two objectives in a single facility.

Design Considerations: Extended detention basins can remove approximately 75% of the total suspended solids contained within the volume of runoff captured in the basin. Design elements of extended detention basins include basin sizing, basin configuration, basin side slopes, basin lining, inlet/outlet structures, and erosion controls. Extended detention basins are appropriate for large drainage areas with low to moderate slopes. The retention capacity should be sufficient considering the average rainfall event for the area.

Maintenance Requirements: Maintenance requirements for extended detention basins include routine inspections, mowing, debris and litter removal, erosion control, structural repairs, nuisance control, and sediment removal.

Vegetative Filter Strips

Description: Filter strips, also known as vegetated buffer strips, are vegetated sections of land similar to grassy swales except they are essentially flat with low slopes, and are designed only to accept runoff as overland sheet flow. They may appear in any vegetated form from grassland to forest, and are designed to intercept upstream flow, lower flow velocity, and spread water out as sheet flow. The dense vegetative cover facilitates conventional pollutant removal through detention, filtration by vegetation, and infiltration.

Filter strips cannot treat high velocity flows, and do not provide enough storage or infiltration to effectively reduce peak discharges to predevelopment levels for design storms. This lack of quantity control favors use in rural or low-density development; however, they can provide water quality benefits even where the impervious cover is as high as 50%. The primary highway application for vegetative filter strips is along rural roadways where runoff that would otherwise discharge directly to a receiving water passes through the filter strip before entering a conveyance system. Properly designed roadway medians and shoulders make effective buffer strips. These devices also can be used on other types of development where land is available and hydraulic conditions are appropriate.

Flat slopes and low to fair permeability of natural subsoil are required for effective performance of filter strips. Although an inexpensive control measure, they are most useful in contributing watershed areas where peak runoff velocities are low as they are unable to treat the high flow velocities typically associated with high impervious cover.

Successful performance of filter strips relies heavily on maintaining shallow unconcentrated flow. To avoid flow channelization and maintain performance, a filter strip should:

- Be equipped with a level spreading device for even distribution of runoff
- Contain dense vegetation with a mix of erosion resistant, soil binding species
- Be graded to a uniform, even and relatively low slope
- Laterally traverse the contributing runoff area

Filter strips can be used upgradient from watercourses, wetlands, or other water bodies along toes and tops of slopes and at outlets of other stormwater management structures. They should be incorporated into street drainage and master drainage planning. The most important criteria for selection and use of this BMP are soils, space, and slope.

Design Considerations: Vegetative filter strips can remove approximately 85% of the total suspended solids contained within the volume of runoff captured. Design elements of vegetative filter strips include uniform, shallow overland flow across the entire filter strip area, hydraulic loading rate, inlet structures, slope, and vegetative cover. The area should be free of gullies or rills which can concentrate flow. Vegetative filter strips are appropriate for small drainage areas with moderate slopes. Other design elements include the following:

- Soils and moisture are adequate to grow relatively dense vegetative stands
- Sufficient space is available
- Slope is less than 12%
- Comparable performance to more expensive structural controls

Maintenance Requirements: Maintenance requirements for vegetative filter strips include pest management, seasonal mowing and lawn care, routine inspections, debris and litter removal, sediment removal, and grass reseeding and mulching.

Constructed Wetlands

Description: Constructed wetlands provide physical, chemical, and biological water quality treatment of stormwater runoff. Physical treatment occurs as a result of decreasing flow velocities in the wetland, and is present in the form of evaporation, sedimentation, adsorption, and/or filtration. Chemical processes include chelation, precipitation, and chemical adsorption. Biological processes include decomposition, plant uptake and removal of nutrients, plus biological transformation and degradation. Hydrology is one of the most influential factors in pollutant removal due to its effects on sedimentation, aeration, biological transformation, and adsorption onto bottom sediments.

The wetland should be designed such that a minimum amount of maintenance is required. The natural surroundings, including such things as the potential energy of a stream or flooding river, should be utilized as much as possible. The wetland should approximate a natural situation and unnatural attributes, such as rectangular shape or rigid channel, should be avoided.

Site considerations should include the water table depth, soil/substrate, and space requirements. Because the wetland must have a source of flow, it is desirable that the water table is at or near the surface. If runoff is the only source of inflow for the wetland, the water level often fluctuates and establishment of vegetation may be difficult. The soil or substrate of an artificial wetland should be loose loam to clay. A perennial baseflow must be present to sustain the artificial wetland. The presence of organic material is often helpful in increasing pollutant removal and retention. A greater amount of space is required for a wetland system than is required for a detention facility treating the same amount of area.

Design Considerations: Constructed wetlands can remove over 90% of the total suspended solids contained within the volume of runoff captured in the wetland. Design elements of constructed wetlands include wetland sizing, wetland configuration, sediment forebay, vegetation, outflow structure, depth of inundation during storm events, depth of micropools, and aeration. Constructed wetlands are appropriate for large drainage areas with low to moderate slopes.

Maintenance Requirements: Maintenance requirements for constructed wetlands include mowing, routine inspections, debris and litter removal, erosion control, nuisance control, structural repairs, sediment removal, harvesting, and maintenance of water levels.

Wet Basins

Description: Wet basins are runoff control facilities that maintain a permanent wet pool and a standing crop of emergent littoral vegetation. These facilities may vary in appearance from natural ponds to enlarged, bermed (manmade) sections of drainage systems and may function as online or offline facilities, although offline configuration is preferable. Offline designs can prevent scour and other damage to the wet pond and minimize costly outflow structure elements needed to accommodate extreme runoff events.

During storm events, runoff inflows displace part or all of the existing basin volume and are retained and treated in the facility until the next storm event. The pollutant removal mechanisms are settling of solids, wetland plant uptake, and microbial degradation. When the wet basin is adequately sized, pollutant removal performance can be excellent, especially for the dissolved fraction. Wet basins also help provide erosion protection for the receiving channel by limiting peak flows during larger storm events. Wet basins are often perceived as a positive aesthetic element in a community and offer significant opportunity for creative pond configuration and landscape design. Participation of an experienced wetland designer is suggested. A significant potential drawback for wet ponds in arid climates is that the contributing watershed for these facilities is often incapable of providing an adequate water supply to maintain the permanent pool, especially during the summer months. Makeup water (i.e., well water or municipal drinking water) is sometimes used to supplement the rainfall/runoff process, especially for wet basin facilities treating watersheds that generate insufficient runoff.

Design Considerations: Wet basins can remove over 90% of the total suspended solids contained within the volume of runoff captured in the basin. Design elements of wet basins include basin sizing, basin configuration, basin side slopes, sediment forebay, inflow and outflow structures, vegetation, depth of permanent pool, aeration, and erosion control. Wet basins are appropriate for large drainage areas with low to moderate slopes.

Maintenance Requirements: Maintenance requirements for wet basins include mowing, routine inspections, debris and litter removal, erosion control, nuisance control, structural repairs, sediment removal, and harvesting.

Attachment 4
Description of BMPs

Grassy Swales

Grassy swales are vegetated channels that convey stormwater and remove pollutants by filtration through grass and infiltration through soil. They require shallow slopes and soils that drain well. Pollutant removal capability is related to channel dimensions, longitudinal slope, and type of vegetation. Optimum design of these components will increase contact time of runoff through the swale and improve pollutant removal rates.

Grassy swales are primarily stormwater conveyance systems. They can provide sufficient control under light to moderate runoff conditions, but their ability to control large storms is limited. Therefore, they are most applicable in low to moderate sloped areas or along highway medians as an alternative to ditches and curb and gutter drainage. Their performance diminishes sharply in highly urbanized settings, and they are generally not effective enough to receive construction stage runoff where high sediment loads can overwhelm the system. Grassy swales can be used as a pretreatment measure for other downstream BMPs, such as extended detention basins. Enhanced grassy swales utilize check dams and wide depressions to increase runoff storage and promote greater settling of pollutants.

Grassy swales can be more aesthetically pleasing than concrete or rock-lined drainage systems and are generally less expensive to construct and maintain. Swales can slightly reduce impervious area and reduce the pollutant accumulation and delivery associated with curbs and gutters. The disadvantages of this technique include the possibility of erosion and channelization over time, and the need for more right-of-way as compared to a storm drain system. When properly constructed, inspected, and maintained, the life
expectancy of a swale is estimated to be 20 years.

Design Considerations:

- Comparable performance to wet basins
- Limited to treating a few acres
- Availability of water during dry periods to maintain vegetation
- Sufficient available land area

The suitability of a swale at a site will depend on land use, size of the area serviced, soil type, slope, imperviousness of the contributing watershed, and dimensions and slope of the swale system. In general, swales can be used to serve areas of less than 10 acres, with slopes no greater than 5 %. The seasonal high water table should be at least 4 feet below the surface. Use of natural topographic lows is encouraged, and natural drainage courses should be regarded as significant local resources to be kept in use.

Maintenance Requirements:

Research in the Austin area indicates that vegetated controls are effective at removing pollutants even when dormant. Therefore, irrigation is not required to maintain growth during dry periods, but may be necessary only to prevent the vegetation from dying.

Attachment 4
Description of BMPs

Vegetation Lined Drainage Ditches

Vegetation lined drainage ditches are similar to grassy swales. These drainage ditches are vegetated channels that convey storm water and remove pollutants by filtration through grass and infiltration through soil. They require soils that drain well. Pollutant removal capability is related to channel dimensions, longitudinal slope, and type of vegetation. Optimum design of these components will increase contact time of runoff through the ditch and improve pollutant removal rates. Vegetation lined drainage ditches are primarily storm water conveyance systems. They have vegetation lined in the low flow channel and may include vegetated shelves.

Vegetation in drainage ditches reduces erosion and removes pollutants by lowering water velocity over the soil surface, binding soil particles with roots, and by filtration through grass and infiltration through soil. Vegetation lined drainage ditches can be used where:

- A vegetative lining can provide sufficient stability for the channel grade by increasing maximum permissible velocity

- Slopes are generally less than 5%, with protection from sheer stress as needed through the use of BMPs, such as erosion control blankets

- Site conditions required to establish vegetation, i.e. climate, soils, topography, are present

Design Criteria: The suitability of a vegetation lined drainage ditch at a site will depend on land use, size of the area serviced, soil type, slope, imperviousness of the contributing watershed, and dimensions and slope of the ditch system. The hydraulic capacity of the drainage ditch and other elements such as erosion, siltation, and pollutant removal capability, must be taken into consideration. Use of natural topographic lows is encouraged, and natural drainage courses should be regarded as significant local resources to be kept in use. Other items to consider include the following:

- Capacity, cross-section shape, side slopes, and grade

- Select appropriate native vegetation

- Construct in stable, low areas to conform with the natural drainage system. To reduce erosion potential, design the channel to avoid sharp bends and steep grades.

- Design and build drainage ditches with appropriate scour and erosion protection. Surface water should be able to enter over the vegetated banks without erosion occurring.

- BMPs, such as erosion control blankets, may need to be installed at the time of seeding to provide stability until the vegetation is fully established. It may also be necessary to divert water from the channel until vegetation is established or to line the channel with sod.

- Vegetated ditches must not be subject to sedimentation from disturbed areas.

• Sediment traps may be needed at channel inlets to prevent entry of muddy runoff and channel sedimentation.

- Availability of water during dry periods to maintain vegetation
- Sufficient available land area

Maintenance:

During establishment, vegetation lined drainage ditches should be inspected, repaired, and vegetation reestablished if necessary. After the vegetation has become established, the ditch should be checked periodically to determine if the channel is withstanding flow velocities without damage. Check the ditch for debris, scour, or erosion and immediately make repairs if needed. Check the channel outlet and all road crossings for bank stability and evidence of piping or scour holes and make repairs immediately. Remove all significant sediment accumulations to maintain the designed carrying capacity. Keep the vegetation in a healthy condition at all times, since it is the primary erosion protection for the channel. Vegetation lined drainage ditches should be seasonally maintained by mowing or irrigating, depending on the vegetation selected. The long-term management of ditches as stable, vegetated, "natural" drainage systems with native vegetation buffers is highly recommended due to the inherent stability offered by grasses, shrubs, trees, and other vegetation.

Research in the Austin area indicates that vegetated controls are effective at removing pollutants even when dormant. Therefore, irrigation is not required to maintain growth during dry periods, but may be necessary only to prevent the vegetation from dying.

Sand Filter Systems

The objective of sand filters is to remove sediment and the pollutants from the first flush of pavement and impervious area runoff. The filtration of nutrients, organics, and coliform bacteria is enhanced by a mat of bacterial slime that develops during normal operations. One of the main advantages of sand filters is their adaptability; they can be used on areas with thin soils, high evaporation rates, low-soil infiltration rates, in limited-space areas, and where groundwater is to be protected.

Since their original inception in Austin, Texas, hundreds of intermittent sand filters have been implemented to treat stormwater runoff. There have been numerous alterations or variations in the original design as engineers in other jurisdictions have improved and adapted the technology to meet their specific requirements. Major types include the Austin Sand Filter, the District of Columbia Underground Sand Filter, the Alexandria Dry Vault Sand Filter, the Delaware Sand Filter, and peat-sand filters which are adapted to provide a sorption layer and vegetative cover to various sand filter designs .

Design Considerations:

- Appropriate for space-limited areas

- Applicable in arid climates where wet basins and constructed wetlands are not appropriate
- High TSS removal efficiency

Cost Considerations:

Filtration Systems may require less land than some other BMPs, reducing the land acquisition cost; however the structure itself is one of the more expensive BMPs. In addition, maintenance cost can be substantial.

Erosion Control Compost

Description: Erosion control compost (ECC) can be used as an aid to control erosion on critical sites during the establishment period of protective vegetation. The most common uses are on steep slopes, swales, diversion dikes, and on tidal or stream banks.

Materials:

New types of erosion control compost are continuously being developed. The Texas Department of Transportation (TxDOT) has established minimum performance standards which must be met for any products seeking to be approved for use within any of TxDOT's construction or maintenance activities. Material used within any TxDOT construction or maintenance activities must meet material specifications in accordance with current TxDOT specifications. TxDOT maintains a website at http://www.txdot.gov/business/contractors_consultants/recycling/compost.htm that provides information on compost specification data.

ECC used for projects not related to TxDOT should also be of quality materials by meeting performance standards and compost specification data. To ensure the quality of compost used as an ECC, products should meet all applicable state and federal regulations, including but not limited to the United States Environmental Protection Agency (USEPA) Code of Federal Regulations (CFR), Title 40, Part 503 Standards for Class A biosolids and Texas Natural Resource Conservation Commission (now named TCEQ) Health and Safety Regulations as defined in the Texas Administration Code (TAC), Chapter 332, and all other relevant requirements for compost products outlined in TAC, Chapter 332. Testing requirements required by the TCEQ are defined in TAC Chapter 332, including Sections §332.71 Sampling and Analysis Requirements for Final Products and §332.72 Final Product Grades. Compost specification data approved by TxDOT are appropriate to use for ensuring the use of quality compost materials or for guidance.
Testing standards are dependent upon the intended use for the compost and ensures product safety, and product performance regarding the product's specific use. The appropriate compost sampling and testing protocols included in the United States Composting Council (USCC) Test Methods for the Examination of Composting and Compost (TMECC) should be conducted on compost products used for ECC to ensure that the products used will not impact public health, safety, and the environment and to promote production and marketing of quality composts that meet analytical standards. TMECC is a laboratory manual that provides protocols for the composting industry and test methods for compost analysis. TMECC provides protocols to sample, monitor, and analyze materials during all stages of the composting process. Numerous

parameters that might be of concern in compost can be tested by following protocols or test methods listed in TMECC. TMECC information can be found at http://www.tmecc.org/tmecc/index.html. The USCC Seal of Testing Assurance (STA) program contains information regarding compost STA certification. STA program information can be found at http://tmecc.org/sta/STA_program_description.html.

Installation:

- Install in accordance with current TxDOT specification.
- Use on slopes 3:1 or flatter.
- Apply a 2 inch uniform layer unless otherwise shown on the plans or as directed.
- When rolling is specified, use a light corrugated drum roller.

Muleh and Compost Filter Socks

Description: Mulch and compost filter socks (erosion control logs) are used to intercept and detain sediment laden run-off from unprotected areas. When properly used, mulch and compost filter socks can be highly effective at controlling sediment from disturbed areas. They cause runoff to pond which allows heavier solids to settle. Mulch and compost filter socks are used during the period of construction near the perimeter of a disturbed area to intercept sediment while allowing water to percolate through. The sock should remain in place until the area is permanently stabilized. Mulch and compost filter socks may be installed in construction areas and temporarily moved during the day to allow construction activity provided it is replaced and properly anchored at the end of the day. Mulch and compost filter socks may be seeded to allow for quick vegetative growth and reduction in run-off velocity.

Materials:

New types of mulch and compost filter socks are continuously being developed. The Texas Department of Transportation (TxDOT) has established minimum performance standards which must be met for any products seeking to be approved for use within any of TxDOT's construction or maintenance activities. Mulch and compost filter socks used within any TxDOT construction or maintenance activities must meet material specifications in accordance with TxDOT specification 5049. TxDOT maintains a website at http://www.txdot.gov/business/contractors_consultants/recycling/compost.htm that provides information on compost specification data.

Mulch and compost filter socks used for projects not related to TxDOT should also be of quality materials by meeting performance standards and compost specification data. To ensure the quality of compost used for mulch and compost filter socks, products should meet all applicable state and federal regulations, including but not limited to the United States Environmental Protection Agency (USEPA) Code of Federal Regulations (CFR), Title 40, Part 503 Standards for Class A biosolids and Texas Natural Resource Conservation Commission Health and Safety Regulations as defined in the Texas Administration Code (TAC), Chapter 332, and all other

relevant requirements for compost products outlined in TAC, Chapter 332. Testing requirements required by the TCEQ are defined in TAC Chapter 332, including Sections §332.71 Sampling and Analysis Requirements for Final Products and §332.72 Final Product Grades. Compost specification data approved by TxDOT are appropriate to use for ensuring the use of quality compost materials or for guidance.

Testing standards are dependent upon the intended use for the compost and ensures product safety, and product performance regarding the product's specific use. The appropriate compost sampling and testing protocols included in the United States Composting Council (USCC) Test Methods for the Examination of Composting and Compost (TMECC) should be conducted on compost products used for mulch and compost filter socks to ensure that the products used will not impact public health, safety, and the environment and to promote production and marketing of quality composts that meet analytical standards. TMECC is a laboratory manual that provides protocols for the composting industry and test methods for compost analysis. TMECC provides protocols to sample, monitor, and analyze materials during all stages of the composting process. Numerous parameters that might be of concern in compost can be tested by following protocols or test methods listed in TMECC. TMECC information can be found at http://www.tmecc.org/tmecc/index.html. The USCC Seal of Testing Assurance (STA) program contains information regarding compost STA certification. STA program information can be found at http://tmecc.org/sta/STA_program_description.html.

Installation:

- Install in accordance with TxDOT Special Specification 5049.
- Install socks (erosion control logs) near the downstream perimeter of a disturbed area to intercept sediment from sheet flow.
- Secure socks in a method adequate to prevent displacement as a result of normal rain events such that flow is not allowed under the socks.
- Inspect and maintain the socks in good condition (including staking, anchoring, etc.). Maintain the integrity of the control, including keeping the socks free of accumulated silt, debris, etc., until the disturbed area has been adequately stabilized.

Sedimentation Chambers (only to be used when there is no space available for other approved BMP's)

Deseription: Sedimentation chambers are stormwater treatment structures that can be used when space is limited such as urban settings. These structures are often tied into stormwater drainage systems for treatment of stormwater prior to entering state waters. The water quality benefits are the removal of sediment and buoyant materials. These structures are not designed as a catch basin or detention basin and not typically used for floodwater attenuation.

Design Considerations: Average rainfall and surface area should be considered when following manufacturer's recommendations for chamber sizing and/or number of units needed to achieve effective TSS removal. If properly sized, 50-80% removal of TSS can be expected.

Attachment 4
Description of BMPs

Maintenance Requirements: Maintenance requirements include routine inspections, sediment, debris and litter removal, erosion control and nuisance control.

PERMIT COMPLIANCE CERTIFICATION

Permit Number:

Name of Permittee:

Date of Issuance:

Upon completion of the activity authorized by this permit and any mitigation required by the permit, sign this certification and return it to the following address:

Regulatory Branch
CESWF-PER-R
U.S. Army Corps of Engineers
P.O. Box 17300
Fort Worth, Texas 76102-0300

Please note that your permitted activity is subject to a compliance inspection by a U.S. Army Corps of Engineers representative. If you fail to comply with this permit you are subject to permit suspension, modification, or revocation.

I hereby certify that the work authorized by the above referenced permit was completed in accordance with the terms and conditions of the said permit, and required mitigation was completed in accordance with the permit conditions.

_____ _____

Signature of Permittee Date

TEXAS HISTORICAL COMMISSION
real places telling real stories

January 31, 2014

W. Nicholas Trierweiler, Ph.D.
AmaTerra Environmental
4009 Banister Lane, Suite 300
Austin, TX 78704

Re: Project review under the Antiquities Code of Texas
Final Report: *Cultural Resource Survey of the Proposed Tarrant Regional Water District/City of Dallas Integrated Pipeline Project in Tarrant, Johnson, Ellis, Navarro, Henderson, and Anderson Counties, and Expansion of the Kennedale Balancing Reservoir in Tarrant County, Texas*
Texas Antiquities Permit #5826
COMPLETED PERMIT

Dear Colleague:

Thank you for your correspondence describing the above referenced project. This letter presents the comments of the Executive Director of the Texas Historical Commission, the state agency responsible for administering the Antiquities Code of Texas.

The Archeology Division is in receipt of the final report, a completed *Abstracts in Texas Contract Archeology* form, and a copy of the report on a tagged PDF CD for the above referenced permit. The submission of the final report, abstract form, and CD demonstrates completion of your permit requirements under Permit #5826.

Thank you for your cooperation in this state review process, and for your efforts to preserve the irreplaceable heritage of Texas. **If you have any questions concerning our review or if we can be of further assistance, please contact Lillie Thompson at 512/463-1858.**

Sincerely,

for
Mark Wolfe
Executive Director

MW/lft

RESOLUTION AUTHORIZING THE ISSUANCE, SALE, AND DELIVERY OF TARRANT REGIONAL WATER DISTRICT, A WATER CONTROL AND IMPROVEMENT DISTRICT, WATER TRANSMISSION FACILITIES CONTRACT REVENUE BONDS (CITY OF DALLAS PROJECT), SERIES 2015, PLEDGING REVENUES FOR THE PAYMENT OF THE BONDS, AND AUTHORIZING OTHER INSTRUMENTS AND PROCEDURES RELATING THERETO

THE STATE OF TEXAS §
COUNTY OF TARRANT §
TARRANT REGIONAL WATER DISTRICT,
A WATER CONTROL AND IMPROVEMENT DISTRICT §

WHEREAS, Tarrant Regional Water District, a Water Control and Improvement District, (formerly known as "Tarrant County Water Control and Improvement District Number One") (the "Issuer" or "District") is a political subdivision of the State of Texas, being a conservation and reclamation district created and functioning under Article 16, Section 59, of the Texas Constitution, pursuant to the general laws of the State of Texas, including Chapters 49 and 51, Texas Water Code, and pursuant to the provisions of Chapter 268, Acts of 1957, 55th Legislature of Texas, Regular Session, as amended (collectively, the "District Act"); and

WHEREAS, a Water Transmission Facilities Financing Agreement, dated November 16, 2010 (the "Contract"), has been duly executed by the Issuer and the City of Dallas, Texas (the "City"), with respect to the acquisition, construction, and financing of an integrated pipeline project (as defined therein and as used herein, the "Project").

WHEREAS, the Issuer will authorize the Series 2015 Bonds (hereinafter defined) pursuant to the Contract, the District Act, and other applicable laws; and

WHEREAS, by adoption of its Resolution Approving an Application for Financial Assistance, dated _____, 2015, the Texas Water Development Board ("TWDB") has agreed to purchase the Issuer's hereinafter authorized bonds; and

WHEREAS, the meeting was open to the public and public notice of the time, place and purpose of said meeting was given pursuant to Chapter 551, Texas Government Code.

THEREFORE, BE IT RESOLVED BY THE BOARD OF DIRECTORS OF TARRANT REGIONAL WATER DISTRICT, A WATER CONTROL AND IMPROVEMENT DISTRICT, THAT:

Section 1. AMOUNT AND PURPOSE OF THE BONDS. The bond or bonds of the Issuer are hereby authorized to be issued and delivered, in one or more series, in an aggregate principal amount not to exceed $140,000,000, and in the manner hereinafter provided, for the purpose of obtaining funds to (i) pay for design, acquisition, and construction costs related to the Dallas Project Component (as defined in the Contract) of the Project, (ii) fund a reserve fund for the Series 2015 Bonds, and (iii) pay costs of issuance of the Series 2015 Bonds.

Section 2. DESIGNATION OF THE BONDS. Each bond issued pursuant to this Resolution shall be designated: "TARRANT REGIONAL WATER DISTRICT, A WATER CONTROL AND IMPROVEMENT DISTRICT, WATER TRANSMISSION FACILITIES CONTRACT REVENUE BOND (CITY OF DALLAS PROJECT), SERIES 2015." Initially there shall be issued, sold, and delivered hereunder a single fully registered bond, without interest coupons, payable in installments of principal (the "Initial Bond"), but the Initial Bond may be assigned and transferred and/or converted into and exchanged for a like aggregate amount of fully registered bonds, without interest coupons, having serial maturities, and in the denomination or denominations of $5,000 or any integral multiple of $5,000, all in the manner hereinafter provided. The term "Series 2015 Bonds" as used in this Resolution shall mean and include collectively the Initial Bond and all substitute bonds exchanged therefor, as well as all other substitute bonds and replacement bonds issued pursuant hereto, and the term "Series 2015 Bond" shall mean any of the Series 2015 Bonds.

Section 3. INITIAL DATE, DENOMINATION, NUMBER, MATURITIES, INITIAL REGISTERED OWNER, AND CHARACTERISTICS OF THE INITIAL BOND. (a) The Initial Bond is hereby authorized to be issued, sold, and delivered hereunder as a single fully registered Bond, without interest coupons, dated _____, 2015, in the denomination and aggregate principal amount of $_____, numbered TR-1, payable in annual installments of principal to the initial registered owner thereof, to-wit: Texas Water Development Board or to the registered assignee or assignees of said Initial Bond or any portion or portions thereof (in each case, the "registered owner"), with the annual installments of principal of the Initial Bond to be payable on the dates, respectively, and in the principal amounts, respectively, stated in the FORM OF INITIAL BOND set forth in this Resolution.

(b) The Initial Bond (i) may be prepaid or paid on the respective scheduled due dates of installments of principal thereof, (ii) may be assigned and transferred, (iii) may be converted and exchanged for other bonds, (iv) shall have the characteristics, and (v) shall be signed and sealed, and the principal of and interest on the Initial Bond shall be payable, all as provided, and in the manner required or indicated, in the FORM OF INITIAL BOND set forth in this Resolution.

Section 4. INTEREST. The unpaid principal balance of the Initial Bond shall bear interest from the date of delivery (the "Issuer Date") of the Initial Bond to the TWDB to the respective scheduled due dates, or to the respective dates of prepayment or redemption, of the installments of principal of the Initial Bond, and such interest shall be payable in the manner, at the rates, and on the dates, respectively, as provided in the FORM OF INITIAL BOND, set forth in this Resolution.

Section 5. FORM OF INITIAL BOND. The form of the Initial Bond, including the form of Registration Certificate of the Comptroller of Public Accounts of the State of Texas to be endorsed on the Initial Bond, shall be substantially as fol1ows:

FORM OF INITIAL BOND

NO. TR-1 $_____

UNITED STATES OF AMERICA
STATE OF TEXAS

TARRANT REGIONAL WATER DISTRICT,
A WATER CONTROL AND IMPROVEMENT DISTRICT,
WATER TRANSMISSION FACILITIES CONTRACT REVENUE BOND
(CITY OF DALLAS PROJECT),
SERIES 2015

TARRANT REGIONAL WATER DISTRICT, A WATER CONTROL AND IMPROVEMENT DISTRICT (the "Issuer"), being a political subdivision of the State of Texas, hereby promises to pay to TEXAS WATER DEVELOPMENT BOARD (the "TWDB") or to the registered assignee or assignees of this Bond or any portion or portions hereof (in each case, the "registered owner") the aggregate principal amount of _____ _____ and __/100 Dollars ($_____) in annual installments of principal due and payable on September 1 in each of the years, in the respective principal amounts, and bearing interest at the respective interest rates, as set forth in the following schedule:

Year	Principal Amount	Interest Rates	Year	Principal Amount	Interest Rates
	$	%		$	%

Interest will be payable, calculated on the basis of a 360-day year composed of twelve 30-day months, from the date of initial delivery of this Bond to the TWDB, on the balance of each such installment of principal, with said interest being payable semiannually on each March 1 and September 1, commencing _____, while this Bond or any portion hereof is outstanding and unpaid.

THE INSTALLMENTS OF PRINCIPAL OF AND THE INTEREST ON this Bond are payable in lawful money of the United States of America, without exchange or collection charges. The installments of principal and the interest on this Bond are payable to the registered owner hereof through the services of BOKF, NA dba BANK OF TEXAS, DALLAS, TEXAS, which is the "Paying Agent/Registrar" for this Bond. Payment of all principal of and interest on this Bond shall be made by the Paying Agent/Registrar to the registered owner hereof on each principal and/or interest payment date by check, dated as of such date, drawn by the Paying Agent/Registrar on, and payable solely from, funds of the Issuer required by the resolution authorizing the issuance of this Bond (the "Bond Resolution") to be on deposit with the Paying Agent/Registrar for such purpose as hereinafter provided; and such check shall be sent by the Paying Agent/Registrar by United States mail, first-class postage prepaid, on each such principal and/or interest payment date, to the registered owner hereof, at the address of the registered owner, as it appeared at the close of business on the 15th day of the month next preceding each such date (the "Record Date") on the Registration Books kept by the Paying Agent/ Registrar, as hereinafter described; provided that, if the TWDA

is the registered owner of this Bond, at the option of the TWDB and at the expense of the Issuer, such payment shall be made by wire transfer pursuant to written directions of the TWDB. The Issuer covenants with the registered owner of this Bond that on or before each principal and/or interest payment date for this Bond it will make available to the Paying Agent/Registrar, from the "Interest and Redemption Fund" created by the Bond Resolution, the amounts required to provide for the payment, in immediately available funds, of all principal of and interest on this Bond, when due.

IF THE DATE for the payment of the principal of or interest on this Bond shall be a Saturday, Sunday, a legal holiday, or a day on which banking institutions in the city where the Paying Agent/Registrar is located are authorized by law or executive order to close, then the date for such payment shall be the next succeeding day which is not such a Saturday, Sunday, legal holiday, or day on which banking institutions are authorized to close; and payment on such date shall have the same force and effect as if made on the original date payment was due.

THIS BOND has been authorized in accordance with the Constitution and laws of the State of Texas in the principal amount of $_____, for the purpose of obtaining funds to (i) pay for design, acquisition, and construction costs related to the Dallas Project Component of the Project, as such terms are defined in the Bond Resolution, consisting generally of a portion of the share of the City of Dallas, Texas (the "City") of the costs of an integrated pipeline to serve the City and the Issuer, (ii) fund a reserve fund for this Bond, and (iii) pay costs of issuance of this Bond.

ON _____ 1, ____, or any date thereafter, the unpaid installments of principal of this Bond may be prepaid or redeemed prior to their scheduled due dates, at the option of the Issuer, with funds derived from any available source, as a whole, or in part, and, if in part, the Issuer shall select and designate the installment or installment of principal, and the amount that is to be redeemed, and if less than a whole principal installment is to be called, the Issuer shall direct the Paying Agent/Registrar to call by lot or other customary method of random selection the portion of the principal installment to be redeemed (only in an integral multiple of $5,000), at the redemption price of the principal amount to be prepaid or redeemed, plus accrued interest to the date fixed for prepayment or redemption.

AT LEAST 30 days prior to the date fixed for any such prepayment or redemption a written notice of such prepayment or redemption shall be mailed by the Paying Agent/Registrar to the registered owner hereof. By the date fixed for any such prepayment or redemption due provision shall be made by the Issuer with the Paying Agent/Registrar for the payment of the required prepayment or redemption price for this Bond or the portion hereof which is to be so prepaid or redeemed, plus accrued interest thereon to the date fixed for prepayment or redemption. If such written notice of prepayment or redemption is given, and if due provision for such payment is made, all as provided above, this Bond, or the portion thereof which is to be so prepaid or redeemed, thereby automatically shall be treated as prepaid or redeemed prior to its scheduled due date, and shall not bear interest after the date fixed for its prepayment or redemption, and shall not be regarded as being outstanding except for the right of the registered owner to receive the prepayment or redemption price plus accrued interest to the date fixed for prepayment or redemption from the Paying Agent/Registrar out of the funds provided for such payment. The Paying Agent/Registrar shall record in the Registration Books all such prepayments or redemptions of principal of this Bond or any portion hereof.

THIS BOND, to the extent of the unpaid or unredeemed principal balance hereof, or any unpaid and unredeemed portion hereof in any integral multiple of $5,000, may be assigned by the initial registered owner hereof and shall be transferred only in the Registration Books of the Issuer kept by the Paying Agent/Registrar acting in the capacity of registrar for the Bonds, upon the terms and conditions set forth in the Bond Resolution. Among other requirements for such transfer, this Bond must be presented and surrendered to the Paying Agent/ Registrar for cancellation, together with proper instruments of assignment, in form and with guarantee of signatures satisfactory to the Paying Agent/Registrar, evidencing assignment by the initial registered owner of this Bond, or any portion or portions hereof in any integral multiple of $5,000, to the assignee or assignees in whose name or names this Bond or any such portion or portions hereof is or are to be transferred and registered. Any instrument or instruments of assignment satisfactory to the Paying Agent/Registrar may be used to evidence the assignment of this Bond or any such portion or portions hereof by the initial registered owner hereof. A new bond or bonds payable to such assignee or assignees (which then will be the new registered owner or owners of such new Bond or Bonds) or to the initial registered owner as to any portion of this Bond which is not being assigned and transferred by the initial registered owner, shall be delivered by the Paying Agent/Registrar in conversion of and exchange for this Bond or any portion or portions hereof, but solely in the form and manner as provided in the next paragraph hereof for the conversion and exchange of this Bond or any portion hereof. The registered owner of this Bond shall be deemed and treated by the Issuer and the Paying Agent/Registrar as the absolute owner hereof for all purposes, including payment and discharge of liability upon this Bond to the extent of such payment, and the Issuer and the Paying Agent/Registrar shall not be affected by any notice to the contrary.

AS PROVIDED above and in the Bond Resolution, this Bond, to the extent of the unpaid or unredeemed principal balance hereof, may be converted into and exchanged for a like aggregate principal amount of fully registered bonds, without interest coupons, payable to the assignee or assignees duly designated in writing by the initial registered owner hereof, or to the initial registered owner as to any portion of this Bond which is not being assigned and transferred by the initial registered owner, in any denomination or denominations in any integral multiple of $5,000 (subject to the requirement hereinafter stated that each substitute bond issued in exchange for any portion of this Bond shall have a single stated principal maturity date), upon surrender of this Bond to the Paying Agent/Registrar for cancellation, all in accordance with the form and procedures set forth in the Bond Resolution. If this Bond or any portion hereof is assigned and transferred or converted each bond issued in exchange for any portion hereof shall have a single stated principal maturity date corresponding to the due date of the installment of principal of this Bond or portion hereof for which the substitute bond is being exchanged, and shall bear interest at the rate applicable to and borne by such installment of principal or portion thereof. Such bonds, respectively, shall be subject to redemption prior to maturity on the same dates and for the same prices as the corresponding installment of principal of this Bond or portion hereof for which they are being exchanged. No such bond shall be payable in installments, but shall have only one stated principal maturity date. AS PROVIDED IN THE BOND RESOLUTION, THIS BOND IN ITS PRESENT FORM MAY BE ASSIGNED AND TRANSFERRED OR CONVERTED ONCE ONLY, and to one or more assignees, but the bonds issued and delivered in exchange for this Bond or any portion hereof may be assigned and transferred, and converted, subsequently, as provided in the Bond Resolution. The Issuer shall pay the Paying Agent/Registrar's standard or customary fees and charges for transferring, converting, and exchanging this Bond or any portion thereof, but the one requesting such transfer, conversion, and exchange shall pay any taxes or governmental charges required to be paid with respect thereto. The Paying Agent/Registrar shall not be required to make any such assignment, conversion, or exchange (i) during the period commencing with the close of business on any Record Date and ending with the opening of business on the next following principal or interest payment date, or, (ii) with respect to any Bond or portion thereof called for prepayment or redemption prior to maturity, within 45 days prior to its prepayment or redemption date.

IN THE EVENT any Paying Agent/Registrar for this Bond is changed by the Issuer, resigns, or otherwise ceases to act as such, the Issuer has covenanted in the Bond Resolution that it promptly will appoint a competent and legally qualified substitute therefor, and promptly will cause written notice thereof to be mailed to the registered owner of this Bond.

IT IS HEREBY certified, recited, and covenanted that this Bond has been duly and validly authorized, issued, and delivered; that all acts, conditions, and things required or proper to be performed, exist, and be done precedent to or in the authorization, issuance, and delivery of this Bond have been performed, existed, and been done in accordance with law; that this Bond and the interest thereon are special obligations of the Issuer which, together with other outstanding parity revenue bonds of the Issuer, are payable from and secured by a first lien on and pledge of the "Gross Revenues", as defined in the Bond Resolution, consisting of payments received by the Issuer from the City, designated as "Dallas Bond Payments", pursuant to a Water Transmission Facilities Financing Agreement, dated November 16, 2010 (the "Contract"), between the Issuer and the City with respect to the acquisition, construction, and financing of an integrated pipeline designated as the "Project" in the Contract. It is specifically provided in the Contract that the City is obligated to make payments in amounts sufficient to pay the principal of and interest on this Bond, when due,

and that such payments will be made solely from the gross revenues of the City's combined waterworks and sewer system.

THE ISSUER IS OBLIGATED TO PAY THE PRINCIPAL OF AND INTEREST ON THIS BOND SOLELY FROM AND TO THE EXTENT OF THE GROSS REVENUES DERIVED FROM THE DALLAS BOND PAYMENTS TO BE RECEIVED FROM THE CITY. NO OTHER ENTITY, INCLUDING THE STATE OF TEXAS, ANY POLITICAL SUBDIVISION THEREOF (OTHER THAN THE CITY), OR ANY OTHER PUBLIC OR PRIVATE BODY, IS OBLIGATED, DIRECTLY, INDIRECTLY, CONTINGENTLY, OR IN ANY OTHER MANNER, TO PAY SUCH PRINCIPAL OR INTEREST FROM ANY OTHER SOURCE WHATSOEVER. THE OWNER OF THIS BOND SHALL NEVER HAVE THE RIGHT TO DEMAND PAYMENT OF THIS BOND OUT OF ANY FUNDS RAISED OR TO BE RAISED BY TAXATION (INCLUDING SPECIFICALLY TAXES RAISED OR TO BE RAISED BY THE CITY) OR FROM ANY OTHER FUNDS OF THE ISSUER EXCEPT THE GROSS REVENUES PLEDGED TO THE PAYMENT OF THIS BOND. NO REPRESENTATION IS MADE HEREIN WITH RESPECT TO THE ANTICIPATED SUFFICIENCY OF THE GROSS REVENUES PLEDGED TO THE PAYMENT OF THIS BOND. NO PART OF THE PHYSICAL PROPERTY OF THE CITY IS ENCUMBERED BY ANY LIEN OR SECURITY INTEREST FOR THE BENEFIT OF THE OWNERS OF THIS BOND.

THE ISSUER has reserved the right, subject to the restrictions stated in the Bond Resolution, to issue Additional Bonds payable from and secured by a first lien on and pledge of the Gross Revenues on a parity with this Bond.

THE ISSUER also has reserved the right to amend the Bond Resolution, with the approval of the owners of 51% of the outstanding bonds secured by a first lien on the Gross Revenues, subject to the restrictions stated in the Bond Resolution.

THE REGISTERED OWNER hereof shall never have the right to demand payment of this Bond or the interest hereon from any source whatsoever other than specified in the Contract and the Bond Resolution.

BY BECOMING the registered owner of this Bond, the registered owner thereby acknowledges all of the terms and provisions of the Bond Resolution, agrees to be bound by such terms and provisions, acknowledges that the Bond Resolution is duly recorded and available for inspection in the official minutes and records of the governing body of the Issuer, and agrees that the terms and provisions of this Bond and the Bond Resolution constitute a contract between the registered owner hereof and the Issuer.

IN WITNESS WHEREOF, the Issuer has caused this Bond to be signed with the manual or facsimile signature of the President of the Board of Directors of the Issuer and countersigned with the manual or facsimile signature of the Secretary of the Board of Directors of the Issuer, has caused the official seal of the Issuer to be duly impressed, or placed in facsimile, on this Bond, and has caused this Bond to be dated as of _____, 2015.

Secretary, Board of Directors	President, Board of Directors

(DISTRICT SEAL)

FORM OF REGISTRATION CERTIFICATE OF THE
COMPTROLLER OF PUBLIC ACCOUNTS:

COMPTROLLER'S REGISTRATION CERTIFICATE: REGISTER NO.

I hereby certify that this Bond has been examined, certified as to validity, and approved by the Attorney General of the State of Texas, and that this Bond has been registered by the Comptroller of Public Accounts of the State of Texas.

Witness my signature and seal this

_____
Comptroller of Public Accounts of the State of Texas

(COMPTROLLER'S SEAL)

Section 6. CHARACTERISTICS OF THE SERIES 2015 BONDS. (a) Registration, Transfer, Conversion and Exchange; Authentication. The Issuer shall keep or cause to be kept at the principal corporate trust office of BOKF, NA dba Bank of Texas, Dallas, Texas (the "Paying Agent/Registrar") books or records for the registration of the transfer, conversion and exchange of the Series 2015 Bonds (the "Registration Books"), and the Issuer hereby appoints the Paying Agent/Registrar as its registrar and transfer agent to keep such books or records and make such registrations of transfers, conversions and exchanges under such reasonable regulations as the Issuer and Paying Agent/Registrar may prescribe; and the Paying Agent/Registrar shall make such registrations, transfers, conversions and exchanges as herein provided. The Paying Agent/Registrar shall obtain and record in the Registration Books the address of the registered owner of each Series 2015 Bond to which payments with respect to the Series 2015 Bonds shall be mailed, as herein provided; but it shall be the duty of each registered owner to notify the Paying Agent/Registrar in writing of the address to which payments shall be mailed, and such interest payments shall not be mailed unless such notice has been given. To the extent possible and under reasonable circumstances, all transfers of Series 2015 Bonds shall be made within three Business Days after request and presentation thereof. The Issuer shall have the right to inspect the Registration Books during regular business hours of the Paying Agent/Registrar, but otherwise the Paying Agent/Registrar shall keep the Registration Books confidential and, unless otherwise required by law, shall not permit their inspection by any other entity. The Paying Agent/Registrar's standard or customary fees and charges for making such registration, transfer, conversion, exchange and delivery of a substitute Series 2015 Bond or Series 2015 Bonds shall be paid as provided in the FORM OF BOND set forth in this Resolution. Registration of assignments, transfers, conversions and exchanges of Series 2015 Bonds shall be made in the manner provided and with the effect stated in the FORM OF BOND set forth in this Resolution. Each substitute Bond shall bear a letter and/or number to distinguish it from each other Bond.

An authorized representative of the Paying Agent/Registrar shall, before the delivery of any such Bond, date and manually sign the Paying Agent/Registrar's Authentication Certificate, and no such Bond shall be deemed to be issued or outstanding unless such Certificate is so executed. The Paying Agent/Registrar promptly shall cancel all paid Series 2015 Bonds surrendered for conversion and exchange. No additional ordinances, orders, or resolutions need be passed or adopted by the

governing body of the Issuer or any other body or person so as to accomplish the foregoing conversion and exchange of any Bond or portion thereof, and the Paying Agent/Registrar shall provide for the printing, execution, and delivery of the substitute Series 2015 Bonds in the manner prescribed herein, and said Series 2015 Bonds shall be of type composition printed on paper with lithographed or steel engraved borders of customary weight and strength. Pursuant to Subchapter D, Chapter 1201, Texas Government Code, the duty of conversion and exchange of Series 2015 Bonds as aforesaid is hereby imposed upon the Paying Agent/Registrar, and, upon the execution of said Certificate, the converted and exchanged Series 2015 Bond shall be valid, incontestable, and enforceable in the same manner and with the same effect as the Series 2015 Bonds which initially were issued and delivered pursuant to this Resolution, approved by the Attorney General, and registered by the Comptroller of Public Accounts.

(b) Payment of Series 2015 Bonds and Interest. The Issuer hereby further appoints the Paying Agent/Registrar to act as the paying agent for paying the principal of and interest on the Series 2015 Bonds, all as provided in this Resolution. The Paying Agent/Registrar shall keep proper records of all payments made by the Issuer and the Paying Agent/Registrar with respect to the Series 2015 Bonds.

(c) In General. The Series 2015 Bonds (i) shall be issued in fully registered form, without interest coupons, with the principal of and interest on such Series 2015 Bonds to be payable only to the registered owners thereof, (ii) may be redeemed prior to their scheduled maturities, (iii) may be transferred and assigned, (iv) may be converted and exchanged for other Series 2015 Bonds, (v) shall have the characteristics, (vi) shall be signed, sealed, executed and authenticated, (vii) shall be payable as to principal and interest, and (viii) shall be administered and the Paying Agent/Registrar and the Issuer shall have certain duties and responsibilities with respect to the Series 2015 Bonds, all as provided, and in the manner and to the effect as required or indicated, in the FORM OF Series 2015 Bond set forth in this Resolution. The Series 2015 Bonds initially issued and delivered pursuant to this Resolution are not required to be, and shall not be, authenticated by the Paying Agent/Registrar, but on each substitute Series 2015 Bond issued in conversion of and exchange for any Series 2015 Bond or Series 2015 Bonds issued under this Resolution the Paying Agent/Registrar shall execute the PAYING AGENT/REGISTRAR'S AUTHENTICATION CERTIFICATE, in the form set forth in the FORM OF SERIES 2015 SUBSTITUTE BOND.

(d) Substitute Paying Agent/Registrar. The Issuer covenants with the registered owners of the Series 2015 Bonds that at all times while the Series 2015 Bonds are outstanding the Issuer will provide a competent and legally qualified bank, trust company, financial institution, or other agency to act as and perform the services of Paying Agent/Registrar for the Series 2015 Bonds under this Resolution, and that the Paying Agent/Registrar will be one entity. The Issuer reserves the right to, and may, at its option, change the Paying Agent/Registrar upon not less than 120 days written notice to the Paying Agent/Registrar, to be effective not later than 60 days prior to the next principal or interest payment date after such notice. In the event that the entity at any time acting as Paying Agent/Registrar (or its successor by merger, acquisition, or other method) should resign or otherwise cease to act as such, the Issuer covenants that promptly it will appoint a competent and legally qualified bank, trust company, financial institution, or other agency to act as Paying Agent/Registrar under this Resolution. Upon any change in the Paying Agent/Registrar, the previous Paying Agent/Registrar promptly shall transfer and deliver the Registration Books (or a copy thereof), along with all other pertinent books and records relating to the Series 2015 Bonds, to the new Paying

Agent/Registrar designated and appointed by the Issuer. Upon any change in the Paying Agent/Registrar, the Issuer promptly will cause a written notice thereof to be sent by the new Paying Agent/Registrar to each registered owner of the Series 2015 Bonds, by United States mail, first-class postage prepaid, which notice also shall give the address of the new Paying Agent/Registrar. By accepting the position and performing as such, each Paying Agent/Registrar shall be deemed to have agreed to the provisions of this Resolution, and a certified copy of this Resolution shall be delivered to each Paying Agent/Registrar.

(e) Reporting Requirements of Paying Agent/Registrar. To the extent required by the Internal Revenue Code of 1986, as amended (the "Code") and the regulations promulgated and pertaining thereto, it shall be the duty of the Paying Agent/Registrar, on behalf of the Issuer, to report to the owners of the Series 2015 Bonds and the Internal Revenue Service (i) the amount of "reportable payments", if any, subject to backup withholding during each year and the amount of tax withheld, if any, with respect to payments of the Series 2015 Bonds and (ii) the amount of interest or amount treating as interest on the Series 2015 Bonds and required to be included in gross income of the owner thereof.

(f) Book-Entry Only System. The Series 2015 Bonds issued in exchange for the Series 2015 Bonds initially issued to the purchaser specified herein shall be initially issued in the form of a separate single fully registered Series 2015 Bond for each of the maturities thereof. Upon initial issuance, the ownership of each such Series 2015 Bond shall be registered in the name of Cede & Co., as nominee of Depository Trust Company of New York ("DTC"), and except as provided in subsection (f) hereof, all of the outstanding Series 2015 Bonds shall be registered in the name of Cede & Co., as nominee of DTC.

With respect to Series 2015 Bonds registered in the name of Cede & Co., as nominee of DTC, the Issuer and the Paying Agent/Registrar shall have no responsibility or obligation to any DTC Participant or to any person on behalf of whom such a DTC Participant holds an interest on the Series 2015 Bonds. Without limiting the immediately preceding sentence, the Issuer and the Paying Agent/Registrar shall have no responsibility or obligation with respect to (i) the accuracy of the records of DTC, Cede & Co. or any DTC Participant with respect to any ownership interest in the Series 2015 Bonds, (ii) the delivery to any DTC Participant or any other person, other than a Bondholder, as shown on the Registration Books, of any notice with respect to the Series 2015 Bonds, including any notice of redemption, or (iii) the payment to any DTC Participant or any other person, other than a Bondholder, as shown in the Registration Books of any amount with respect to principal of, premium, if any, or interest on, as the case may be, the Series 2015 Bonds. Notwithstanding any other provision of this Resolution to the contrary, the Issuer and the Paying Agent/Registrar shall be entitled to treat and consider the person in whose name each Series 2015 Bond is registered in the Registration Books as the absolute owner of such Series 2015 Bond for the purpose of payment of principal, premium, if any, and interest, as the case may be, with respect to such Bond, for the purpose of giving notices of redemption and other matters with respect to such Bond, for the purpose of registering transfers with respect to such Bond, and for all other purposes whatsoever. The Paying Agent/Registrar shall pay all principal of, premium, if any, and interest on the Series 2015 Bonds only to or upon the order of the respective owners, as shown in the Registration Books as provided in this Resolution, or their respective attorneys duly authorized in writing, and all such payments shall be valid and effective to fully satisfy and discharge the Issuer's obligations with respect to payment of principal of, premium, if any, and interest on, or as the case

may be, the Series 2015 Bonds to the extent of the sum or sums so paid. No person other than an owner, as shown in the Registration Books, shall receive a Series 2015 Bond certificate evidencing the obligation of the Issuer to make payments of principal, premium, if any, and interest, as the case may be, pursuant to this Resolution. Upon delivery by DTC to the Paying Agent/Registrar of written notice to the effect that DTC has determined to substitute a new nominee in place of Cede & Co., and subject to the provisions in this Resolution with respect to interest checks being mailed to the registered owner at the close of business on the Record Date, the word "Cede & Co." in this Resolution shall refer to such new nominee of DTC. The Issuer has executed and delivered to DTC a "Blanket Letter of Representation" to effect the use of a book-entry-only system for obligations such as the Series 2015 Bonds.

(g) Successor Securities Depository; Transfers Outside Book-Entry Only System. In the event that the Issuer or the Paying Agent/Registrar determines that DTC is incapable of discharging its responsibilities described herein and in the Blanket Letter of Representation of the Issuer to DTC and that it is in the best interest of the beneficial owners of the Series 2015 Bonds that they be able to obtain certificated Series 2015 Bonds, the Issuer or the Paying Agent/Registrar shall (i) appoint a successor securities depository, qualified to act as such under Section 17(a) of the Securities and Exchange Act of 1934, as amended, notify DTC and DTC Participants of the appointment of such successor securities depository and transfer one or more separate Series 2015 Bonds to such successor securities depository or (ii) notify DTC and DTC Participants of the availability through DTC of Series 2015 Bonds and transfer one or more separate Series 2015 Bonds to DTC Participants having Series 2015 Bonds credited to their DTC accounts. In such event, the Series 2015 Bonds shall no longer be restricted to being registered in the Registration Books in the name of Cede & Co., as nominee of DTC, but may be registered in the name of the successor securities depository, or its nominee, or in whatever name or names Bondholders transferring or exchanging Series 2015 Bonds shall designate, in accordance with the provisions of this Resolution.

(h) Payments to Cede & Co. Notwithstanding any other provision of this Resolution to the contrary, so long as any Bond is registered in the name of Cede & Co., as nominee of DTC, all payments with respect to principal of, premium, if any, and interest on, or as the case may be, such Bond and all notices with respect to such Bond shall be made and given, respectively, in the manner provided in the representation letter of the Issuer to DTC.

Section 7. FORM OF SERIES 2015 SUBSTITUTE BONDS. The form of all Series 2015 Bonds issued in conversion and exchange or replacement of any other Series 2015 Bond or portion thereof, including the form of Paying Agent/Registrar's Certificate to be printed on each of such Series 2015 Bonds, and the Form of Assignment to be printed on each of the Series 2015 Bonds, shall be, respectively, substantially as follows with such appropriate variations, omissions, or insertions as are permitted or required by this Resolution.

FORM OF SERIES 2015 SUBSTITUTE BOND

NO.____ PRINCIPAL AMOUNT
$_____

UNITED STATES OF AMERICA
STATE OF TEXAS
TARRANT REGIONAL WATER DISTRICT,
A WATER CONTROL AND IMPROVEMENT DISTRICT,
WATER TRANSMISSION FACILITIES CONTRACT REVENUE BOND
(CITY OF DALLAS, TEXAS PROJECT),
SERIES 2015

INTEREST RATE	MATURITY DATE	ISSUE DATE	CUSIP NO.
%	September 1, ____	_____, 2015	

ON THE MATURITY DATE specified above TARRANT REGIONAL WATER DISTRICT, A WATER CONTROL AND IMPROVEMENT DISTRICT (the "Issuer"), being a political subdivision of the State of Texas, hereby promises to pay to CEDE & CO. or to the registered assignee hereof (either being hereinafter called the "registered owner") the principal amount of _____ DOLLARS and to pay interest thereon, calculated on the basis of a 360-day year composed of twelve 30-day months, from the Issue Date specified above, to the Maturity Date specified above, or the date of redemption prior to maturity, at the interest rate per annum specified above; with interest being payable semiannually on each March 1 and September 1, commencing _____, except that if the date of authentication of this Bond is later than the first Record Date (hereinafter defined), such principal amount shall bear interest from the interest payment date next preceding the date of authentication, unless such date of authentication is after any Record Date (hereinafter defined) but on or before the next following interest payment date, in which case such principal amount shall bear interest from such next following interest payment date.

THE PRINCIPAL OF AND INTEREST ON this Bond are payable in lawful money of the United States of America, without exchange or collection charges. The principal of this Bond shall be paid to the registered owner hereof upon presentation and surrender of this Bond at maturity or upon the date fixed for its redemption prior to maturity, at the principal corporate trust office of BOKF, NA dba BANK OF TEXAS, Dallas, Texas, which is the "Paying Agent/Registrar" for this Bond. The payment of interest on this Bond shall be made by the Paying Agent/Registrar to the registered owner hereof on each interest payment date by check dated as of such interest payment date, drawn by the Paying Agent/Registrar on, and payable solely from, funds of the Issuer required by the resolution authorizing the issuance of the Bonds (the "Bond Resolution") to be on deposit with the Paying Agent/Registrar for such purpose as hereinafter provided; and such check shall be sent by the Paying Agent/Registrar by United States mail, first-class postage prepaid, on each such interest payment date, to the registered owner hereof, at the address of the registered owner, as it appeared at the close of business on the 15th day of the month next preceding each such date (the "Record Date") on the Registration Books kept by the Paying Agent/Registrar, as hereinafter

described; provided, however, for Bonds, the registered owner of which is the Texas Water Development Board (the "TWDB"), at the option of the TWDB and at the expense of the Issuer, such payment shall be made by wire transfer pursuant to written directions of the TWDB. However, notwithstanding the foregoing provisions, (1) the payment of such interest may be made by any other method acceptable to the Paying Agent/Registrar and requested by, and at the risk and expense of, the registered owner hereof and (2) upon the written request, and at the risk and expense of, the registered owner of any Bond of this Series in the amount of $1,000,000 or more, delivered to the Paying Agent/Registrar not less than 15 days prior to any interest payment date, payment of the interest due on such Bond on such date shall be paid on such date by wire transfer to any designated account in the United States of America which has available to it the wire service facilities of the Federal Reserve Bank. Any accrued interest due upon the redemption of this Bond prior to maturity as provided herein shall be paid to the registered owner at the principal corporate trust office of the Paying Agent/Registrar upon presentation and surrender of this Bond for redemption and payment at the principal corporate trust office of the Paying Agent/Registrar. The Issuer covenants with the registered owner of this Bond that on or before each principal payment date, interest payment date, and accrued interest payment date for this Bond it will make available to the Paying Agent/Registrar, from the "Interest and Redemption Fund" created by the Bond Resolution, the amounts required to provide for the payment, in immediately available funds, of all principal of and interest on the Bonds, when due.

IF THE DATE for the payment of the principal of or interest on this Bond shall be a Saturday, Sunday, a legal holiday, or a day on which banking institutions in the city where the Paying Agent/Registrar is located are authorized by law or executive order to close, then the date for such payment shall be the next succeeding day which is not such a Saturday, Sunday, legal holiday, or day on which banking institutions are authorized to close; and payment on such date shall have the same force and effect as if made on the original date payment was due.

THIS BOND is one of a series of bonds (the "Bonds") dated as of _____, 2015, authorized in accordance with the Constitution and laws of the State of Texas in the principal amount of $_____ for the purpose of obtaining funds to (i) pay for design, acquisition, and constructions costs related to the Dallas Project Component of the Project, as such terms are defined in the Bond Resolution, consisting generally of a portion of the share of the City of Dallas, Texas (the "City") of the costs of an integrated pipeline to serve the City and the Issuer, (ii) fund a reserve fund for the Bonds, and (iii) pay costs of issuance of the Bonds.

ON _____, ____, or any date thereafter, the Bonds may be redeemed prior to their scheduled maturities, at the option of the Issuer, with funds derived from any available source, as a whole, or in part, and, if in part, the Issuer shall select and designate the particular maturities and amounts of Bonds to be redeemed, and if less than all of the Bonds of a maturity are to be redeemed, the Issuer shall direct the Paying Agent/Registrar to call by lot or other customary method of random selection the particular Bonds or portions thereof to be redeemed (only in an integral multiple of $5,000), at the redemption price of the principal amount to be redeemed, plus accrued interest to the date fixed for redemption.

DURING ANY PERIOD in which ownership of the Bonds is determined by a book entry at a securities depository for the Bonds, if fewer than all of the Bonds of the same maturity and bearing the same interest rate are to be redeemed, the particular Bonds of such maturity and bearing such interest rate shall be selected in accordance with the arrangements between the Issuer and the securities depository.

AT LEAST 30 days prior to the date fixed for any redemption of Bonds or portions thereof prior to maturity at the option of the Issuer, a written notice of such redemption shall be sent by the Paying Agent/Registrar by United States mail, first-class postage prepaid, to the registered owner appearing on the Registration Books at the close of business on the day next preceding the date of mailing of such notice; provided, however, that any notice so mailed shall be conclusively presumed to have been duly given and the failure to receive such notice, or any defect therein shall not affect the validity or effectiveness of the proceedings for the redemption of any Bond at the option of the Issuer. By the date fixed for any such redemption due provision shall be made with the Paying Agent/Registrar for the payment of the required redemption price for the Bonds or portions thereof which are to be so redeemed, plus accrued interest thereon to the date fixed for redemption. If such written notice of redemption is mailed and if due provision for such payment is made, all as provided above, the Bonds or portions thereof which are to be so redeemed thereby automatically shall be treated as redeemed prior to their scheduled maturities, and they shall not bear interest after the date fixed for redemption, and they shall not be regarded as being outstanding except for the right of the registered owner to receive the redemption price plus accrued interest from the Paying Agent/Registrar out of the funds provided for such payment. If a portion of any Bond shall be redeemed a substitute Bond or Bonds having the same maturity date, bearing interest at the same rate, in any denomination or denominations in any integral multiple of $5,000, at the written request of the registered owner, and in aggregate principal amount equal to the unredeemed portion thereof, will be issued to the registered owner upon the surrender thereof for cancellation, at the expense of the Issuer, all as provided in the Bond Resolution.

THIS BOND OR ANY PORTION OR PORTIONS HEREOF IN ANY INTEGRAL MULTIPLE OF $5,000 may be assigned and shall be transferred only in the Registration Books of the Issuer kept by the Paying Agent/Registrar acting in the capacity of registrar for the Bonds, upon the terms and conditions set forth in the Bond Resolution. Among other requirements for such assignment and transfer, this Bond must be presented and surrendered to the Paying Agent/Registrar, together with proper instruments of assignment, in form and with guarantee of signatures satisfactory to the Paying Agent/Registrar, evidencing assignment of this Bond or any portion or portions hereof in any integral multiple of $5,000 to the assignee or assignees in whose name or names this Bond or any such portion or portions hereof is or are to be transferred and registered. The form of Assignment printed or endorsed on this Bond shall be executed by the registered owner or its duly authorized attorney or representative, to evidence the assignment hereof. A new Bond or Bonds payable to such assignee or assignees (which then will be the new registered owner or owners of such new Bond or Bonds), or to the previous registered owner in the case of the assignment and transfer of only a portion of this Bond, may be delivered by the Paying Agent/Registrar in conversion of and exchange for this Bond, all in the form and manner as provided in the next paragraph hereof for the conversion and exchange of other bonds. The Issuer shall pay the Paying Agent/Registrar's standard or customary fees and charges for making such transfer, but the one requesting such transfer shall pay any taxes or other governmental charges required to be paid with respect thereto. The Paying Agent/Registrar shall not be required to make transfers of registration

of this Bond or any portion hereof (i) during the period commencing with the close of business on any Record Date and ending with the opening of business on the next following principal or interest payment date, or, (ii) with respect to any Bond or any portion thereof called for redemption prior to maturity, within 45 days prior to its redemption date. The registered owner of this Bond shall be deemed and treated by the Issuer and the Paying Agent/Registrar as the absolute owner hereof for all purposes, including payment and discharge of liability upon this Bond to the extent of such payment, and the Issuer and the Paying Agent/Registrar shall not be affected by any notice to the contrary.

ALL BONDS OF THIS SERIES are issuable solely as fully registered bonds, without interest coupons, in the denomination of any integral multiple of $5,000. As provided in the Bond Resolution, this Bond, or any unredeemed portion hereof, may, at the request of the registered owner or the assignee or assignees hereof, be converted into and exchanged for a like aggregate principal amount of fully registered bonds, without interest coupons, payable to the appropriate registered owner, assignee, or assignees, as the case may be, having the same maturity date, and bearing interest at the same rate, in any denomination or denominations in any integral multiple of $5,000 as requested in writing by the appropriate registered owner, assignee, or assignees, as the case may be, upon surrender of this Bond to the Paying Agent/Registrar for cancellation, all in accordance with the form and procedures set forth in the Bond Resolution. The Issuer shall pay the Paying Agent/Registrar's standard or customary fees and charges for transferring, converting, and exchanging any Bond or any portion thereof, but the one requesting such transfer, conversion, and exchange shall pay any taxes or governmental charges required to be paid with respect thereto as a condition precedent to the exercise of such privilege of conversion and exchange. The Paying Agent/Registrar shall not be required to make any such conversion and exchange (i) during the period commencing with the close of business on any Record Date and ending with the opening of business on the next following principal or interest payment date, or, (ii) with respect to any Bond or portion thereof called for redemption prior to maturity, within 45 days prior to its redemption date.

IN THE EVENT any Paying Agent/Registrar for this Bond is changed by the Issuer, resigns, or otherwise ceases to act as such, the Issuer has covenanted in the Bond Resolution that it promptly will appoint a competent and legally qualified substitute therefor, and promptly will cause written notice thereof to be mailed to the registered owners of this Bond.

IT IS HEREBY certified, recited, and covenanted that this Bond has been duly and validly authorized, issued, and delivered; that all acts, conditions, and things required or proper to be performed, exist, and be done precedent to or in the authorization, issuance, and delivery of this Bond have been performed, existed, and been done in accordance with law; that this Bond and the interest thereon are special obligations of the Issuer, which, together with other outstanding parity revenue bonds of the Issuer, are payable from and secured by a first lien on and pledge of the "Gross Revenues", as defined in the Bond Resolution, consisting of payments received by the Issuer from the City designated as "Dallas Bond Payments", pursuant to a Water Transmission Facilities Financing Agreement, dated November 16, 2010 (the "Contract"), between the Issuer and the City with respect to the acquisition, construction, and financing of an integrated pipeline designated as the "Project" in the Contract. It is specifically provided in the Contract that the City is obligated to make payments in amounts sufficient to pay the principal of and interest on this Bond, when due, and that such payments will be made solely from the gross revenues of the City's combined waterworks and sewer system.

THE ISSUER IS OBLIGATED TO PAY THE PRINCIPAL OF AND INTEREST ON THIS BOND SOLELY FROM AND TO THE EXTENT OF THE GROSS REVENUES DERIVED FROM THE DALLAS BOND PAYMENTS TO BE RECEIVED FROM THE CITY. NO OTHER ENTITY, INCLUDING THE STATE OF TEXAS, ANY POLITICAL SUBDIVISION THEREOF (OTHER THAN THE CITY), OR ANY OTHER PUBLIC OR PRIVATE BODY, IS OBLIGATED, DIRECTLY, INDIRECTLY, CONTINGENTLY, OR IN ANY OTHER MANNER, TO PAY SUCH PRINCIPAL OR INTEREST FROM ANY OTHER SOURCE WHATSOEVER. THE OWNER OF THIS BOND SHALL NEVER HAVE THE RIGHT TO DEMAND PAYMENT OF THIS BOND OUT OF ANY FUNDS RAISED OR TO BE RAISED BY TAXATION (INCLUDING SPECIFICALLY TAXES RAISED OR TO BE RAISED BY THE CITY) OR FROM ANY OTHER FUNDS OF THE ISSUER EXCEPT THE GROSS REVENUES PLEDGED TO THE PAYMENT OF THIS BOND. NO REPRESENTATION IS MADE HEREIN WITH RESPECT TO THE ANTICIPATED SUFFICIENCY OF THE GROSS REVENUES PLEDGED TO THE PAYMENT OF THIS BOND. NO PART OF THE PHYSICAL PROPERTY OF THE CITY IS ENCUMBERED BY ANY LIEN OR SECURITY INTEREST FOR THE BENEFIT OF THE OWNERS OF THIS BOND.

THE ISSUER has reserved the right, subject to the restrictions stated in the Bond Resolution, to issue Additional Bonds payable from and secured by a first lien on and pledge of the Gross Revenues on a parity with this Bond.

THE ISSUER also has reserved the right to amend the Bond Resolution, with the approval of the owners of 51% of the outstanding bonds secured by a first lien on the Gross Revenues, subject to the restrictions stated in the Bond Resolution.

THE REGISTERED OWNER hereof shall never have the right to demand payment of this Bond or the interest hereon from any source whatsoever other than specified in the Contract and the Bond Resolution.

BY BECOMING the registered owner of this Bond, the registered owner thereby acknowledges all of the terms and provisions of the Bond Resolution, agrees to be bound by such terms and provisions, acknowledges that the Bond Resolution is duly recorded and available for inspection in the official minutes and records of the governing body of the Issuer, and agrees that the terms and provisions of this Bond and the Bond Resolution constitute a contract between each registered owner hereof and the Issuer.

IN WITNESS WHEREOF, the Issuer has caused this Bond to be signed with the facsimile signature of the President of the Board of Directors of the Issuer and countersigned with the facsimile signature of the Secretary of the Board of Directors of the Issuer, and has caused the official seal of the Issuer to be duly impressed, or placed in facsimile, on this Bond.

xxxxx	xxxxx
Secretary, Board of Directors	President, Board of Directors

(DISTRICT SEAL)

FORM OF PAYING AGENT/REGISTRAR'S AUTHENTICATION CERTIFICATE

PAYING AGENT/REGISTRAR'S AUTHENTICATION CERTIFICATE

(To be executed if this Bond is not accompanied by an executed Registration Certificate of the Comptroller of Public Accounts of the State of Texas)

It is hereby certified that this Bond has been issued under the provisions of the Bond Resolution described in the text of this Bond; and that this Bond has been issued in conversion or replacement of, or in exchange for, a bond, bonds, or a portion of a bond or bonds of a series which originally was approved by the Attorney General of the State of Texas and registered by the Comptroller of Public Accounts of the State of Texas.

Dated

BOKF, NA dba BANK OF TEXAS,
Dallas, Texas

By _____
Authorized Representative

FORM OF ASSIGNMENT:

ASSIGNMENT

FOR VALUE RECEIVED, the undersigned sells, assigns and transfers unto

Please Insert Social Security or
Other Identifying Number of Assignee

/_____/

_____

(Name and Address of Assignee)

the within Bond and does hereby irrevocably constitute and appoint _____ to transfer said Bond on the books kept for registration thereof with full power of substitution in the premises.

Date: _____

_____

Signature Guaranteed: _____

NOTICE: The signature to this assignment must correspond with the name as it appears upon the face of the within Bond in every particular, without alteration or enlargement or any change whatever; and

NOTICE: Signature(s) must be guaranteed by an eligible guarantor institution participating in a Securities Transfer Association recognized signature guarantee program.

Section 8. ADDITIONAL DEFINITIONS. In addition to the definitions heretofore provided for, the following terms as used in this Resolution shall have the meanings set forth below, unless the text hereof specifically indicates otherwise:

The term "Additional Bonds" shall mean the additional parity revenue bonds permitted to be authorized in the future on a parity with the Bonds, as hereinafter provided in Section 19 hereof.

The term "Board" shall mean the Board of Directors of the District, being the governing body of the District, and it is further resolved that the declarations and covenants of the District contained in this Resolution are made by, and for and on behalf of the Board and the District, and are binding upon the Board and the District for all purposes.

The terms "Bond Resolution" and "Resolution" shall mean this resolution authorizing the Series 2015 Bonds.

The term "Bonds" shall mean (i) the unpaid and unrefunded Series 2012 Bonds and Series 2014 Bonds to be outstanding after the delivery of the Series 2015 Bonds, (ii) the Series 2015 Bonds, and (ii) any Additional Bonds.

The term "Business Day" shall mean a day other than a Saturday, a Sunday, a legal holiday, or a day on which banking institutions are authorized by law or executive order to close in the City or the city where the principal corporate trust office of the Paying Agent/Registrar is located.

The term "City" shall mean the City of Dallas, Texas.

The term "Contract" shall mean the "Water Transmission Facilities Financing Agreement," dated November 16, 2010, between the Issuer and the City.

The term "Credit Facility" shall mean (i) a policy of insurance or a surety bond, issued by an issuer of policies of insurance insuring the timely payment of debt service on governmental obligations, provided that a nationally recognized rating agency having an outstanding rating on outstanding Bonds would rate the Bonds fully insured by a standard policy issued by the issuer on the date the policy of insurance or surety bond is issued in its two highest generic rating categories for such obligations; and (ii) a letter or line of credit issued by any financial institution, provided that a rating agency having an outstanding rating on the Bonds would rate the Bonds in its two highest generic rating categories for such Bonds on the date such letter of line of credit is issued if the letter or line of credit proposed to be issued by such financial institution secured the timely payment of the entire principal amount of the Bonds and the interest thereon.

The term "Dallas Bond Payments" shall mean the payments received by the Issuer from the City pursuant to Contract and designated in the Contract as "Dallas Bond Payments."

The term "Dallas Project Component" shall have the same meaning given such term in the Contract.

The term "Gross Revenues" shall mean the Dallas Bond Payments received by the Issuer from the City pursuant to the Contract, together with any interest earnings thereon.

The terms "Issuer" and "District" shall mean Tarrant Regional Water District, a Water Control and Improvement District.

The term "Project" shall mean the integrated pipeline designated as the "Project" in the Contract.

The term "Series 2012 Bond Resolution" shall mean the resolution authorizing the issuance of the Series 2012 Bonds.

The term "Series 2012 Bonds" shall mean all unpaid and unrefunded "Tarrant Regional Water District, a Water Control and Improvement District, Water Transmission Facilities Contract Revenue Bonds (City of Dallas Project), Series 2012.

The term "Series 2014 Bond Resolution" shall mean the resolution authorizing the issuance of the Series 2014 Bonds.

The term "Series 2014 Bonds" shall mean all unpaid and unrefunded "Tarrant Regional Water District, a Water Control and Improvement District, Water Transmission Facilities Contract Revenue Bonds (City of Dallas Project), Series 2014.

The term "Series 2015 Bonds" shall mean collectively the Initial Bond as described and defined in Sections 1, 2, and 3 of this Bond Resolution, and all substitute bonds exchanged therefor, as well as all other substitute bonds and replacement bonds issued pursuant to this Resolution, all as provided for herein.

The term "TWDB" shall mean the Texas Water Development Board.

The terms "year" and "fiscal year" shall mean the District's fiscal year, which initially shall be the twelve month period ending on September 30, but which subsequently may be any other 12 month period hereafter established by the District as a fiscal year for the purposes of the Contract and any resolution authorizing the Bonds.

Section 9. PLEDGE. (a) The Series 2015 Bonds and the interest thereon, are and shall be secured equally and ratably, on a parity, by and payable from a first lien on and pledge of the Gross Revenues; and the Series 2015 Bonds are Additional Bonds payable from and secured by, on a parity with all outstanding Bonds, a first lien on and pledge of the Gross Revenues, as permitted by Section 19 of the Series 2012 Bond Resolution and the Series 2014 Bond Resolution.

(b) It is specifically recognized that the City is required to make Dallas Bond Payments from the gross revenues of its combined waterworks and sewer system, to the Issuer pursuant to the Contract sufficient to enable the Issuer to make all deposits and payments provided for herein, and that the Bonds, and the interest thereon, are and shall be payable from and secured by a first lien on and pledge of all of the Gross Revenues, and said Gross Revenues are further pledged irrevocably to the establishment and maintenance of the Funds hereinafter created.

(c) Chapter 1208, Government Code, applies to the issuance of the Bonds and the pledge of the Gross Revenues granted by the Issuer under this Section, and is therefore valid, effective, and perfected. Should Texas law be amended at any time while the Bonds are outstanding and unpaid, the result of such amendment being that the pledge of the revenues granted by the Issuer under this Section is to be subject to the filing requirements of Chapter 9, Business & Commerce Code, in order to preserve to the registered owners of the Bonds a security interest in said pledge, the Issuer agrees to take such measures as it determines are reasonable and necessary under Texas law to comply with the applicable provisions of Chapter 9, Business & Commerce Code and enable a filing of a security interest in said pledge to occur.

Section 10. SPECIAL FUNDS. All Gross Revenues shall be accounted for separate and apart from all other funds of the Issuer, and the following special Funds created and established by the Series 2012 Bond Resolution are hereby confirmed and shall be and maintained on the books of the Issuer, so long as any of the Bonds, or interest thereon, are outstanding and unpaid:

(a) the Revenue Fund;

(b) the Interest and Redemption Fund; and

(c) the Reserve Fund.

Section 11. REVENUE FUND. All Gross Revenues shall be credited as received by the Issuer to the Revenue Fund, and shall be deposited from the Revenue Fund into the Interest and Redemption Fund and the Reserve Fund in the manner and amounts hereinafter provided.

Section 12. INTEREST AND REDEMPTION FUND. (a) There shall be deposited into the Interest and Redemption Fund the following:

(i) immediately after the delivery of the Bonds all accrued interest, if any, from the proceeds from the sale of the Bonds;

(ii) on or before each interest payment date on the Bonds, an amount sufficient, together with other amounts, if any, on hand therein, to pay the interest coming due on the Bonds on each such interest payment date;

(iii) on or before each principal payment date on the Bonds, an amount sufficient, together with other amounts, if any, on hand therein, to pay the principal coming due on the Bonds on each such principal payment date; and

(iv) on or before each redemption date for the Bonds, an amount sufficient, together with other amounts, if any, on hand therein, to pay the redemption price, including interest accrued, on Bonds called for redemption on such redemption date.

(b) The Interest and Redemption Fund shall be used solely to pay the principal of and interest on the Bonds when due, whether upon scheduled payment dates or upon earlier redemption.

Section 13. RESERVE FUND. Subject to the provisions of Section 28 of this Resolution, the Issuer shall maintain in the Reserve Fund an amount not less in market value than the average annual principal and interest requirements on all Bonds outstanding (the "Required Reserve") as of the date of any computation thereof. Immediately after the delivery of the Initial Bond, the Issuer shall cause to be deposited from the proceeds from the sale and delivery of the Initial Bond into the Reserve Fund an amount, if any, sufficient to cause the Reserve Fund to have on deposit an amount equal to the Required Reserve.

The Reserve Fund shall be used to pay the principal of or interest on the Bonds, at any time when there is not sufficient money available in the Interest and Redemption Fund for such purpose, or to pay the principal of or interest on the last maturing Bonds.

For the purpose of determining the amount on deposit to the credit of the Reserve Fund investments in which money in such account shall have been invested shall be computed at the market value of such investment. The amount on deposit to the credit of the Reserve Fund shall be computed by the Issuer at least annually, and shall be computed immediately upon any withdrawal from the Reserve Fund. The Issuer may at any time substitute a Credit Facility for all or part of the cash or other Credit Facility on deposit in, or held for the benefit of, the Reserve Fund. The amount of a Credit Facility shall be the remaining amount or remaining coverage amount thereof.

When and so long as the money and investments and/or coverage afforded by a Credit Facility in the Reserve Fund total not less than the Required Reserve, no deposits need be made to the credit of the Reserve Fund; but when and if the Reserve Fund at any time contains less than the Required Reserve, the Issuer covenants and agrees to require the City to cure the deficiency in the Required Reserve pursuant to the Contract within twelve (12) months from the date the deficiency in funds occurred. So long as the Reserve Fund contains the Required Reserve in market value, all amounts in excess of Required Reserve, if any, shall, at least annually, on or before the 25th day of August of each year, be deposited to the credit of the Interest and Redemption Fund.

Section 14. PROJECT CONSTRUCTION FUND. There shall be established a Project Construction Fund with the Issuer's depository bank and upon the delivery of each series of Bonds (other than Bonds issued for refunding purposes), the net proceeds of such Bonds, after making any required deposits to the Interest and Redemption Fund and the Reserve Fund for such Bonds, shall be deposited into the Project Construction Fund. Money in the Project Construction Fund shall be subject to disbursements by the Issuer for payment of all costs incurred in carrying out the purposes for which the Bonds are issued.

Section 15. INVESTMENTS. Money in any Fund maintained pursuant to this Resolution or any resolution authorizing Additional Bonds may, at the option of the Issuer, be invested in any or all of the authorized investments described in the Public Funds Investment Act, Chapter 2256, Texas Government Code (or any successor statute), in which the Issuer may purchase, sell and invest its funds and funds under its control. Such deposits and investments shall be made consistent with the estimated requirements of such Funds, and any obligation in which money is so invested shall be kept and held at the bank at which the Fund is maintained for the benefit of the owners of the Bonds, and shall be promptly sold and the proceeds of sale applied to the making of all payments required to be made from the Fund from which the investment was made. All earnings from the deposit or investment of any such Fund shall be credited to such Fund. All investment earnings on

deposit in the Interest and Redemption Fund shall reduce the amounts which otherwise would be required to be deposited therein, with the result that the City's principal and/or interest payments under the Contract shall be reduced accordingly.

Section 16. DEFICIENCIES OR SURPLUSES IN FUNDS. (a) If the Issuer should fail at any time to deposit into the Interest and Redemption Fund and the Reserve Fund created by this Resolution or any resolution authorizing Additional Bonds the full amounts required, amounts equivalent to such deficiencies shall be set apart and paid into said Funds from the first available Gross Revenues, and such payments shall be in addition to the amounts otherwise required to be deposited into said Funds.

(b) Subject to making the required deposits to the Interest and Redemption Fund and the Reserve Fund when and as required by this Resolution, excess Gross Revenues may be used by the Issuer for any lawful purpose related to the Dallas Project Component of the Project.

Section 17. ISSUER'S EXPENSES. The Gross Revenues in excess of those necessary to establish and maintain the Funds as required in this Resolution, or as hereafter may be required in connection with the issuance of Additional Bonds, shall be used by the Issuer to pay its expenses attributable to the Bonds and the Project, including the fees and charges of the Paying Agent/Registrar, all to the extent provided in the Contract.

Section 18. SECURITY FOR FUNDS. All Funds created by this Resolution or any resolution authorizing Additional Bonds shall be secured in the manner prescribed by law, including particularly, the Public Funds Collateral Act, Chapter 2257, Texas Government Code, for the security of public funds, and such Funds shall be used only for the purposes and in the manner permitted or required by this Resolution.

Section 19. ADDITIONAL BONDS. The Issuer reserves the right to issue additional parity revenue bonds ("Additional Bonds") for the purpose of completing the acquisition, by purchase and construction, of the Project in accordance with the Contract, and/or for the purpose of refunding any of the Bonds. Such Additional Bonds shall be considered, constitute, and be defined as "Bonds", for all purposes of this Resolution and the Contract, and when issued and delivered, they shall be payable from and secured by a first lien on and pledge of the Gross Revenues, in the same manner and to the same extent as the other Bonds; and all of the Bonds shall in all respects be on a parity and of equal dignity. The Additional Bonds may be issued in one or more installments or series, provided, however, that no such installment or series shall be issued unless:

(a) a certificate is executed by the President and Secretary of the Board of Directors of the Issuer to the effect that no default exists in connection with the Contract or any of the covenants or requirements of the resolution or resolutions authorizing the issuance of all then outstanding Bonds, and that the Reserve Fund contains the amount then required to be on deposit therein.

(b) the resolution authorizing the issuance of such installment or series of Additional Bonds shall provide for the payment of the principal of and interest on such Additional Bonds and shall confirm the Reserve Fund, as additional security for all such Additional Bonds, and the Reserve Fund shall be increased to the extent required to cause the Reserve Fund to be maintained in an amount not less than the Required Reserve after the issuance of such then proposed Additional

Bonds (or any greater amount as may, at the option of the Issuer, be provided for in any resolution authorizing the issuance of any Additional Bonds), and shall make provision for funding such Reserve Fund from Gross Revenues, or, at the option of the Issuer, from proceeds of such Additional Bonds or other available sources. The Reserve Fund may be funded in whole or in part initially, or may be funded in whole or in part from Gross Revenues by approximately equal periodic payments, not less than annual, and within not more than five years from the date of such then proposed Additional Bonds.

All calculations of principal and interest requirements of any Bonds made in connection with the issuance of any then proposed Additional Bonds shall be made as of the date of such Additional Bonds, and also in making calculations for such purpose, or for any other purpose under any resolution authorizing any Bonds, the principal amounts of any Bonds which must be redeemed prior to maturity pursuant to any applicable mandatory redemption requirements hall be deemed to be maturing amounts of principal.

Section 20. ACCOUNTS AND RECORDS. The Issuer shall keep proper books of records and accounts, separate from all other records and accounts of the Issuer, in which complete and correct entries shall be made of all transactions relating to the Contract. The Issuer shall have said books audited once each Issuer fiscal year by a Certified Public Accountant.

Section 21. ACCOUNTING REPORTS. Within one hundred fifty days after the close of each Issuer fiscal year hereafter, the Issuer will furnish, without cost, to any owner of at least twenty-five percent (25%) of any outstanding Bonds who may so request, a signed or certified copy of a report by a Certified Public Accountant covering such fiscal year, showing the following information:

(a) A detailed statement of all Gross Revenues;

(b) Balance sheet as of the end of said fiscal year;

(c) Accountant's comment regarding the manner in which the Issuer has complied with the requirements of this Resolution and his recommendations, if any, for any changes or improvements.

Section 22. INSPECTION. Any owner or owners of any Bonds shall have the right at all reasonable times to inspect all records, accounts, and data of the Issuer relating to the Contract and the Funds created by this Resolution.

Section 23. SPECIAL COVENANTS. The Issuer further covenants as follows:

(a) that other than for the payment of the Bonds, the Gross Revenues have not in any manner been pledged to the payment of any debt or obligation of the Issuer.

(b) that while any of the Bonds are outstanding, the Issuer will not, with the exception of the Additional Bonds expressly permitted by this Resolution to be issued, additionally encumber the Gross Revenues, unless said encumbrance is made junior and subordinate in all respects to the

liens, pledges, covenants, and agreements of each resolution authorizing the issuance of the Bonds, but the right of the Issuer to issue obligations for any lawful purpose payable from a subordinate lien on the Gross Revenues is specifically recognized and retained.

(c) that the Issuer will carry out all of its obligations under the Contract; and when or if necessary will promptly enforce and cause the City to carry out all of its obligations under the Contract, for the benefit of the Issuer and the owners of the Bonds, by all legal and equitable means, including the use of mandamus proceedings against the City.

Section 24. BONDS ARE SPECIAL OBLIGATIONS. The Bonds shall be special obligations of the Issuer payable from the pledged Gross Revenues, and the registered owner or owners of the Bonds shall never have the right to demand payment thereof from any source other than as provided for in the Contract and this Bond Resolution. The Issuer is not authorized to, and shall not levy, collect, or use any tax of any nature to pay the principal of or interest on any of the Bonds.

Section 25. AMENDMENT OF RESOLUTION. (a) The holders or owners of Bonds aggregating at least a majority in principal amount of the aggregate principal amount of then outstanding Bonds shall have the right to approve any amendment to any resolution authorizing the issuance of Bonds, which may be deemed necessary or desirable by the Issuer, provided, however, that nothing herein contained shall permit or be construed to permit the amendment of the terms and conditions in said resolutions or in the Bonds so as to:

(1) Make any change in the maturity of the outstanding Bonds;

(2) Reduce the rate of interest borne by any of the outstanding Bonds;

(3) Reduce the amount of the principal payable on the outstanding Bonds;

(4) Modify the terms of payment of principal of or interest on the outstanding Bonds, or impose any conditions with respect to such payment;

(5) Affect the rights of the holders of less than all of the Bonds then outstanding;

(6) Change the minimum percentage of the principal amount of Bonds necessary for consent to such amendment.

(b) If at any time the Issuer shall desire to amend a resolution under this Section, the Issuer shall cause notice of the proposed amendment to be published in a financial newspaper or journal published in the City of New York, New York, or in the City of Austin, Texas, once during each calendar week for at least two successive calendar weeks. Such notice shall briefly set forth the nature of the proposed amendment and shall state that a copy thereof is on file at the principal office of each Paying Agent/Registrar of any Bonds for inspection by all owners of Bonds. Such publication is not required, however, if notice in writing is given to each owner of Bonds.

(c) Whenever at any time not less than thirty days, and within one year, from the date of the first publication of notice or other service of written notice the Issuer shall receive an instrument or instruments executed by the owners of at least a majority in aggregate principal

amount of all Bonds and then outstanding, which instrument or instruments shall refer to the proposed amendment described in said notice and which specifically consent to and approve such amendment in substantially the form of the copy thereof on file as aforesaid, the Issuer may adopt the amendatory resolution in substantially the same form.

(d) Upon the adoption of any amendatory resolution pursuant to the provisions of this Section, the resolution being amended shall be deemed to be amended in accordance with the amendatory resolution, and the respective rights, duties, and obligations of the Issuer and all the holders or owners of then outstanding Bonds and all future Bonds shall thereafter be determined, exercised, and enforced hereunder, subject in all respects to such amendment.

(e) Any consent given by the owner of a Bond pursuant to the provisions of this Section shall be irrevocable for a period of six months from the date of the first publication of the notice provided for in this Section, and shall be conclusive and binding upon all future owners of the same Bond during such period. Such consent may be revoked at any time after six months from the date of the first publication of such notice by the owner who gave such consent, or by a successor in title, by filing notice thereof with the Paying Agent/Registrar for such Bond, and the Issuer, but such revocation shall not be effective if the owners of at least a majority in aggregate principal amount of the then outstanding Bonds as in this Section defined have, prior to the attempted revocation, consented to and approved the amendment.

(f) For the purpose of this Section, the ownership of any Bond shall be ascertained by the registration books pertaining thereto kept by the Paying Agent/Registrar therefor. The Issuer may conclusively assume that such holding or ownership continues until written notice to the contrary is served upon the Issuer.

Section 26. DEFEASANCE OF BONDS. (a) The Bonds and the interest thereon shall be deemed to be paid, retired, and no longer outstanding (a "Defeased Bond") within the meaning of this Resolution, except to the extent provided in subsection (d) of this Section, when payment of the principal of such Bond, plus interest thereon to the due date (whether such due date be by reason of maturity, upon redemption, or otherwise) either (i) shall have been made or caused to be made in accordance with the terms thereof (including the giving of any required notice of redemption), or (ii) shall have been provided for on or before such due date by irrevocably depositing with or making available to the Paying Agent/Registrar for such payment (1) lawful money of the United States of America sufficient to make such payment or (2) Government Obligations which mature as to principal and interest in such amounts and at such times as will insure the availability, without reinvestment, of sufficient money to provide for such payment, and when proper arrangements have been made by the Issuer with the Paying Agent/Registrar for the payment of its services until all Defeased Bonds shall have become due and payable. At such time as a Bond shall be deemed to be a Defeased Bond hereunder, as aforesaid, such Bond and the interest thereon shall no longer be secured by, payable from, or entitled to the benefits of, the Gross Revenues as provided in this Resolution, and such principal and interest shall be payable solely from such money or Government Obligations.

(b) Any moneys so deposited with the Paying Agent/Registrar may at the written direction of the Issuer also be invested in Government Obligations, maturing in the amounts and times as hereinbefore set forth, and all income from such Government Obligations received by the

Paying Agent/Registrar which is not required for the payment of the Bonds and interest thereon, with respect to which such money has been so deposited, shall be turned over to the Issuer, or deposited as directed in writing by the Issuer.

(c) The term "Government Obligations" as used in this Section shall mean (i) direct, noncallable obligations of the United States of America, including obligations that are unconditionally guaranteed by the United States of America, (ii) noncallable obligations of an agency or instrumentality of the United States of America, including obligations that are unconditionally guaranteed or insured by the agency or instrumentality and that, on the date the Board of Directors adopts or approves proceedings authorizing the issuance of refunding bonds or otherwise provide for the funding of an escrow to effect the defeasance of the Bonds, are rated as to investment quality by a nationally recognized investment rating firm not less than "AAA" or its equivalent, and (iii) noncallable obligations of a state or an agency or a county, municipality, or other political subdivision of a state that have been refunded and that, on the date the Board of Directors adopts or approves proceedings authorizing the issuance of refunding bonds or otherwise provide for the funding of an escrow to effect the defeasance of the Bonds, are rated as to investment quality by a nationally recognized investment rating firm no less than "AAA" or its equivalent.

(d) Until all Defeased Bonds shall have become due and payable, the Paying Agent/Registrar shall perform the services of Paying Agent/Registrar for such Defeased Bonds the same as if they had not been defeased, and the Issuer shall make proper arrangements to provide and pay for such services as required by this Resolution.

Section 27. DAMAGED, MUTILATED, LOST, STOLEN, OR DESTROYED BONDS. (a) Replacement Bonds. In the event any outstanding Bond is damaged, mutilated, lost, stolen, or destroyed, the Paying Agent/Registrar shall cause to be printed, executed, and delivered, a new bond of the same principal amount, maturity, and interest rate, as the damaged, mutilated, lost, stolen, or destroyed Bond, in replacement for such Bond in the manner hereinafter provided.

(b) Application for Replacement Bonds. Application for replacement of damaged, mutilated, lost, stolen, or destroyed Bonds shall be made by the registered owner thereof to the Paying Agent/Registrar. In every case of loss, theft, or destruction of a Bond, the registered owner applying for a replacement bond shall furnish to the Issuer and to the Paying Agent/Registrar such security or indemnity as may be required by them to save each of them harmless from any loss or damage with respect thereto. Also, in every case of loss, theft, or destruction of a Bond, the registered owner shall furnish to the Issuer and to the Paying Agent/Registrar evidence to their satisfaction of the loss, theft, or destruction of such Bond, as the case may be. In every case of damage or mutilation of a Bond, the registered owner shall surrender to the Paying Agent/Registrar for cancellation the Bond so damaged or mutilated.

(c) No Default Occurred. Notwithstanding the foregoing provisions of this Section, in the event any such Bond shall have matured, and no default has occurred which is then continuing in the payment of the principal of, redemption premium, if any, or interest on the Bond, the Issuer may authorize the payment of the same (without surrender thereof except in the case of a damaged or mutilated Bond) instead of issuing a replacement Bond, provided security or indemnity is furnished as above provided in this Section.

(d) Charge for Issuing Replacement Bonds. Prior to the issuance of any replacement bond, the Paying Agent/Registrar shall charge the registered owner of such Bond with all legal, printing, and other expenses in connection therewith. Every replacement bond issued pursuant to the provisions of this Section by virtue of the fact that any Bond is lost, stolen, or destroyed shall constitute a contractual obligation of the Issuer whether or not the lost, stolen, or destroyed Bond shall be found at any time, or be enforceable by anyone, and shall be entitled to all the benefits of this Resolution equally and proportionately with any and all other Bonds duly issued under this Resolution.

(e) Authority for Issuing Replacement Bonds. In accordance with Chapter 1201, Texas Government Code, this Section of this Resolution shall constitute authority for the issuance of any such replacement bond without necessity of further action by the governing body of the Issuer or any other body or person, and the duty of the replacement of such bonds is hereby authorized and imposed upon the Paying Agent/Registrar, and the Paying Agent/Registrar shall authenticate and deliver such Bonds in the form and manner and with the effect, as provided in Section 6(d) of this Resolution for Bonds issued in conversion and exchange for other Bonds.

Section 28. COVENANTS REGARDING TAX-EXEMPTION. (a) Covenant. The Issuer covenants to refrain from any action which would adversely affect, or to take such action to assure, the treatment of the Series 2015 Bonds as obligations described in section 103 of the Code, the interest on which is not includable in the "gross income" of the holder for purposes of federal income taxation. In furtherance thereof, the Issuer covenants as follows:

(1) to take any action to assure that no more than 10 percent of the proceeds of the Series 2015 Bonds or the projects financed therewith (less amounts deposited into a reserve fund, if any) are used for any "private business use," as defined in section 141(b)(6) of the Code, or if more than 10 percent of the proceeds or the projects financed therewith are so used, such amounts, whether or not received by the Issuer, with respect to such private business use, do not, under the terms of this Resolution or any underlying arrangement, directly or indirectly, secure or provide for the payment of more than 10 percent of the debt service on the Series 2015 Bonds, in contravention of section 141(b)(2) of the Code;

(2) to take any action to assure that in the event that the "private business use" described in subsection (a) hereof exceeds five percent of the proceeds of the Series 2015 Bonds or the projects financed therewith (less amounts deposited into a reserve fund, if any) then the amount in excess of five percent is used for a "private business use" which is "related" and not "disproportionate," within the meaning of section 141(b)(3) of the Code, to the governmental use;

(3) to take any action to assure that no amount which is greater than the lesser of $5,000,000, or five percent of the proceeds of the Series 2015 Bonds (less amounts deposited into a reserve fund, if any) is, directly or indirectly, used to finance loans to persons, other than state or local governmental units, in contravention of section 141(c) of the Code;

(4) to refrain from taking any action that would otherwise result in the Series 2015 Bonds being treated as "private activity bonds" within the meaning of section 141(b) of the Code;

(5) to refrain from taking any action that would result in the Series 2015 Bonds being "federally guaranteed" within the meaning of section 149(b) of the Code;

(6) to refrain from using any portion of the proceeds of the Series 2015 Bonds, directly or indirectly, to acquire or to replace funds which were used, directly or indirectly, to acquire investment property (as defined in section 148(b)(2) of the Code) which produces a materially higher yield over the term of the Series 2015 Bonds, other than investment property acquired with --

(A) proceeds of the Series 2015 Bonds invested for a reasonable temporary period of 3 years or less or, in the case of a refunding bond, for a period of 30 days or less until such proceeds are needed for the purpose for which the Series 2015 Bonds are issued,

(B) amounts invested in a bona fide debt service fund, within the meaning of section 1.148-1(b) of the Treasury Regulations, and

(C) amounts deposited in any reasonably required reserve or replacement fund to the extent such amounts do not exceed 10 percent of the stated principal amount (or, in the case of a discount, the issue price) of the Series 2015 Bonds;

(7) to otherwise restrict the use of the proceeds of the Series 2015 Bonds or amounts treated as proceeds of the Series 2015 Bonds, as may be necessary, so that the Series 2015 Bonds do not otherwise contravene the requirements of section 148 of the Code (relating to arbitrage), section 149(g) of the Code (relating to hedge bonds), and, to the extent applicable, section 149(d) of the Code (relating to advance refundings); and

(8) to pay to the United States of America at least once during each five-year period (beginning on the date of delivery of the Series 2015 Bonds) an amount that is at least equal to 90 percent of the "Excess Earnings," within the meaning of section 148(f) of the Code and to pay to the United States of America, not later than 60 days after the Series 2015 Bonds have been paid in full, 100 percent of the amount then required to be paid as a result of Excess Earnings under section 148(f) of the Code.

(b) Rebate Fund. In order to facilitate compliance with the above covenant (a)(8), a "Rebate Fund" is hereby established by the Issuer for the sole benefit of the United States of America, and such fund shall not be subject to the claim of any other person, including without limitation, the bondholders. The Rebate Fund is established for the additional purpose of compliance with section 148 of the Code.

(c) Compliance with Code. For purposes of the foregoing (a)(1) and (a)(2), the Issuer understands that the term "proceeds" includes "disposition proceeds" as defined in the Treasury Regulations. It is the understanding of the Issuer that the covenants contained herein are intended

to assure compliance with the Code and any regulations or rulings promulgated by the U.S. Department of the Treasury pursuant thereto. In the event that regulations or rulings are hereafter promulgated which modify or expand provisions of the Code, as applicable to the Series 2015 Bonds, the Issuer will not be required to comply with any covenant contained herein to the extent that such failure to comply, in the opinion of nationally-recognized bond counsel, will not adversely affect the exemption from federal income taxation of interest on the Series 2015 Bonds under section 103 of the Code. In the event that regulations or rulings are hereafter promulgated which impose additional requirements which are applicable to the Series 2015 Bonds, the Issuer agrees to comply with the additional requirements to the extent necessary, in the opinion of nationally-recognized bond counsel, to preserve the exemption from federal income taxation of interest on the Series 2015 Bonds under section 103 of the Code. In furtherance of such intention, the Issuer hereby authorizes and directs its President or General Manager to execute any documents, certificates or reports required by the Code and to make such elections, on behalf of the Issuer, which may be permitted by the Code as are consistent with the purpose for the issuance of the Series 2015 Bonds. The Issuer covenants to comply with the covenants contained in this Section after defeasance of the Series 2015 Bonds.

(d) Written Procedures. Unless superseded by another action of the Issuer to ensure compliance with the covenants contained herein regarding private business use, remedial actions, arbitrage and rebate, the Issuer hereby adopts and establishes the instructions attached hereto as Exhibit A as their written procedures applicable to Bonds issued pursuant to the Contract.

Section 29. ALLOCATION OF, AND LIMITATION ON, EXPENDITURES FOR THE PROJECT. The Issuer covenants to account for the expenditure of sale proceeds and investment earnings to be used for the Project on its books and records by allocating proceeds to expenditures within 18 months of the later of the date that (1) the expenditure is made, or (2) the Project is completed. The foregoing notwithstanding, the Issuer shall not expend sale proceeds or investment earnings thereon more than 60 days after the later of (1) the fifth anniversary of the delivery of the Series 2015 Bonds, or (2) the date the Series 2015 Bonds are retired, unless the Issuer obtains an opinion of nationally-recognized bond counsel that such expenditure will not adversely affect the tax-exempt status of the Series 2015 Bonds. For purposes hereof, the Issuer shall not be obligated to comply with this covenant if it obtains an opinion that such failure to comply will not adversely affect the excludability for federal income tax purposes from gross income of the interest.

Section 30. DISPOSITION OF PROJECT. The Issuer covenants that the property constituting the Project will not be sold or otherwise disposed in a transaction resulting in the receipt by the Issuer of cash or other compensation, unless the Issuer obtains an opinion of nationally-recognized bond counsel that such sale or other disposition will not adversely affect the tax-exempt status of the Bonds. For purposes of the foregoing, the portion of the property comprising personal property and disposed in the ordinary course shall not be treated as a transaction resulting in the receipt of cash or other compensation. For purposes hereof, the Issuer shall not be obligated to comply with this covenant if it obtains an opinion that such failure to comply will not adversely affect the excludability for federal income tax purposes from gross income of the interest.

Section 31. CUSTODY, APPROVAL, AND REGISTRATION OF INITIAL BOND; CO-BOND COUNSEL'S OPINION, CUSIP NUMBERS, AND PREAMBLE. The President of the

Board of Directors of the Issuer is hereby authorized to have control of the Initial Bond issued hereunder and all necessary records and proceedings pertaining to the Initial Bond pending its delivery and its investigation, examination, and approval by the Attorney General of the State of Texas, and its registration by the Comptroller of Public Accounts of the State of Texas. Upon registration of the Initial Bond said Comptroller of Public Accounts (or a deputy designated in writing to act for said Comptroller) shall manually sign the Comptroller's Registration Certificate on the Initial Bond, and the seal of said Comptroller shall be impressed, or placed in facsimile, on the Initial Bond. The approving legal opinion of the Issuer's Co-Bond Counsel and the assigned CUSIP numbers may, at the option of the Issuer, be printed on the Initial Bond or on any Series 2015 Bonds issued and delivered in conversion of and exchange or replacement of any Series 2015 Bond, but neither shall have any legal effect, and shall be solely for the convenience and information of the registered owners of the Series 2015 Bonds. The preamble to this Resolution is hereby adopted and made a part hereof for all purposes.

Section 32. INTEREST EARNINGS ON SERIES 2015 BOND PROCEEDS. Interest earnings derived from the investment of proceeds from the sale of the Series 2015 Bonds shall be used along with other bond proceeds for the acquisition and construction of the Project in accordance with the Contract; provided that after completion of the Project, if any of such interest earnings remain on hand, such interest earnings shall be deposited in the Interest and Redemption Fund. It is further provided, however, that any interest earnings on bond proceeds which are required to be rebated to the United States of America pursuant to this Resolution in order to prevent the Series 2015 Bonds from being arbitrage bonds shall be so rebated and not considered as interest earnings for the purposes of this Section.

Section 33. ESCROW AGREEMENT. If required by the TWDB as a condition to the purchase of the Bonds, the President, any Vice President, the Secretary, and/or the General Manager is authorized to execute and deliver an escrow agreement in substantially the form attached as Exhibit C. In such case, proceeds of the Bonds required to be deposited under an escrow agreement shall be disposed of and released in accordance with TWDB Rules Relating to Financial Programs or as otherwise authorized and directed by the TWDB.

Section 34. SALE OF SERIES 2015 BONDS. The Series 2015 Bonds are hereby sold and shall be delivered to the TWDB at a purchase price equal to 100% of the principal amount thereof. The officers of the Issuer are authorized to do any and all things necessary in connection with the issuance of the Series 2015 Bonds, and are authorized to execute and deliver such certificates as are necessary or appropriate in connection with the issuance of the Series 2015 Bonds. It is hereby officially found, determined, and declared that the terms of this sale are the most advantageous reasonably obtainable. The Initial Bond shall be registered in the name of the TWDB or its designee.

Section 35. TWDB REQUIREMENTS. The Issuer covenants and agrees, so long as the TWDB owns all of the Series 2015 Bonds, as follows:

(a) FINAL ACCOUNTING. The Issuer shall render a final accounting to the TWDB in reference to the total costs incurred by the Issuer with proceeds of the Series 2015 Bonds.

(b) SURPLUS BOND PROCEEDS. To the extent that any proceeds of the Series 2015 Bonds remain after payment of all costs to be paid with proceeds of the Series 2015 Bonds, such surplus proceeds shall be used to purchase or redeem and cancel the Series 2015 Bonds, in inverse order of their maturity, owned by the TWDB; provided that any remaining amounts less than $5,000 shall be deposited to the Interest and Sinking Fund.

(c) ANNUAL REPORTS. Annual audits of the Issuer required by Section 20 hereof shall be delivered to the TWDB within 120 days of the close of each fiscal year.

(d) COMPLIANCE WITH THE TWDB'S RULES AND REGULATIONS. The Issuer shall comply with the rules and regulations of the TWDB, and shall maintain any insurance on the District's Water System in an amount determined by the TWDB to be sufficient to protect the TWDB's interest. Additionally, the Issuer covenants to invest the proceeds received from the sale of the Series 2015 Bonds only in accordance with the Public Funds Investment Act, Chapter 2256, Texas Government Code, as amended, and to secure such proceeds as required by the Public Securities Collateral Act, Chapter 2257, Texas Government Code, as amended.

(e) CONSTRUCTION FUND. The Issuer shall maintain on its books a Construction Fund, separate and apart from all other funds of the District, into which it shall deposit and disburse proceeds of the Series 2015 Bonds (except for any proceeds required by this Resolution to be deposited into the Interest and Redemption Fund and the Reserve Fund).

(f) ENVIRONMENTAL INDEMNIFICATION. The Issuer agrees to indemnify, hold harmless, and protect the TWDB from any and all claims, causes of action or damages to the person or property of third parties arising from the sampling, analysis, transport and/or removal and disposition of any contaminated sewage sludge, contaminated sediments and/or contaminated media that may be generated by the Issuer, its contractors, consultants, agents, officials and employees as a result of activities relating to the project financed with proceeds of the Series 2015 Bonds to the extent permitted by law.

(g) WATER CONSERVATION PLAN. The Issuer will implement and/or assist in the implementation of water conservation plans approved by the TWDB.

Section 36. ATTORNEY GENERAL FEES. The Issuer hereby authorizes and directs payment, from legally available funds of the Issuer, of the nonrefundable examination fee of the Attorney General of the State of Texas required by Section 1202.004, Texas Government Code, as amended.

Section 37. FURTHER PROCEDURES. The President and the Secretary of the Board of Directors and the General Manager and the Finance Director of the Issuer, and all other officers, employees, and agents of the Issuer, and each of them, shall be and they are hereby expressly authorized, empowered, and directed from time to time and at any time to do and perform all such acts and things and to execute, acknowledge, and deliver in the name and on behalf of the Issuer all such instruments, whether or not herein mentioned, as may be necessary or desirable in order to carry out the terms and provisions of this Resolution, and all details in connection therewith. In case any officer whose signature shall appear on any Series 2015 Bond shall cease to be such officer

before the delivery of such Series 2015 Bond, such signature shall nevertheless be valid and sufficient for all purposes the same as if such officer had remained in office until such delivery.

Section 38. CONTINUING DISCLOSURE UNDERTAKING.

(a) Annual Reports.

The Issuer shall provide or cause the City to provide annually to the MSRB, within six months after the end of each fiscal year of the City ending in or after 2015, financial information and operating data (i) of the general type included in the final Official Statement authorized by Section 34 of this Resolution, being the information described in Exhibit B hereto. Any financial information so to be provided shall be (1) prepared in accordance with the accounting principles described in Exhibit B hereto, or such other accounting principles as the City may be required to employ from time to time pursuant to state law or regulation, and (2) audited, if the City commissions an audit of such statements and the audit is completed within the period during which they must be provided. If the audit of such financial statements of the City are not complete within such period, then the Issuer shall provide or cause the City to provide unaudited financial information and operating data which is customarily prepared by the City by the required time to the MSRB, and will provide audited information when and if the audit report becomes available.

If the City changes its fiscal year, the Issuer will notify or cause the City to notify the MSRB the change (and of the date of the new fiscal year end) prior to the next date by which the Issuer or the City otherwise would be required to provide financial information and operating data pursuant to this Section.

The financial information and operating date to be provided pursuant to this Section may be set forth in full in one or more documents or may be included by specific reference to any document (including an official statement or other offering document, if it is available from the MSRB) that theretofore has been provided to the MSRB or filed with the SEC.

(b) Disclosure Event Notices.

The Issuer shall notify or cause the City to notify the MSRB, in a timely manner, of any of the following events with respect to the Series 2015 Bonds, not in excess of ten Business Days after occurrence of the event:

1. Principal and interest payment delinquencies;

2. Non-payment related defaults, if material;

3. Unscheduled draws on debt service reserves reflecting financial difficulties;

4. Unscheduled draws on credit enhancements reflecting financial difficulties;

5. Substitution of credit or liquidity providers, or their failure to perform;

6. Adverse tax opinions, the issuance by the Internal Revenue Service of

proposed or final determinations of taxability, Notices of Proposed Issue (IRS Form 5701-TEB) or other material notices or determinations with respect to the tax status of the security, or other material events affecting the tax status of the security;

7. Modifications to the rights of security holders, if material;

8. Bond calls, if material, and tender offers;

9. Defeasances;

10. Release, substitution or sale of property securing repayment of the securities, if material;

11. Rating changes;

12. Bankruptcy, insolvency, receivership or similar event of the City;

13. The consummation of a merger, consolidation, or acquisition involving the City or the sale of all or substantially all of the assets of the City, other than in the ordinary course of business, the entry into a definitive agreement to undertake such an action or the termination of a definitive agreement relating to any such actions, other than pursuant to its terms, if material; and

14. Appointment of a successor or additional trustee or the change of name of a trustee, if material.

The Issuer shall notify or cause the City to notify the MSRB, in a timely manner, of any failure by the Issuer or the City to provide financial information or operating data in accordance with Section 37(a) of this Resolution by the time required by such Section. As used in clause 12 above, the phrase "bankruptcy, insolvency, receivership or similar event" means the appointment of a receiver, fiscal agent, or similar officer for the Issuer in a proceeding under the U.S. Bankruptcy Code or in any other proceeding under state or federal law in which a court or governmental authority has assumed jurisdiction over substantially all of the assets or business of the Issuer, or if jurisdiction has been assumed by leaving the Board of Directors and official or officers of the Issuer in possession but subject to the supervision and orders of a court or governmental authority, or the entry of an order confirming a plan of reorganization, arrangement or liquidation by a court or governmental authority having supervision or jurisdiction over substantially all of the assets or business of the Issuer.

(c) Limitations, Disclaimers, and Amendments.

The Issuer shall be obligated to observe and perform or cause the City to observe and perform the covenants specified in this Section, except that the Issuer in any event will give notice of any deposit made in accordance with Section 26 hereof that causes Series 2015 Bonds no longer to be Outstanding.

The provisions of this Section are for the sole benefit of the Holders and beneficial owners of the Series 2015 Bonds, and nothing in this Section, express or implied, shall give any benefit or

any legal or equitable right, remedy, or claim hereunder to any other person. The Issuer undertakes to provide or cause the City to provide only the financial information, operating data, financial statements, and notices which it has expressly agreed to provide pursuant to this Section and does not hereby undertake to provide or cause to be provided any other information that may be relevant or material to a complete presentation of the City's financial results, condition or prospects or hereby undertake to update any information provided in accordance with this Section or otherwise, except as expressly provided herein. The Issuer does not make any representation or warranty concerning such information or its usefulness to a decision to invest in or sell Series 2015 Bonds at any future date.

UNDER NO CIRCUMSTANCES SHALL THE ISSUER BE LIABLE TO THE HOLDER OR BENEFICIAL OWNER OF ANY SERIES 2015 BOND OR ANY OTHER PERSON, IN CONTRACT OR TORT, FOR DAMAGES RESULTING IN WHOLE OR IN PART FROM ANY BREACH BY THE ISSUER, WHETHER NEGLIGENT OR WITHOUT FAULT ON ITS PART, OF ANY COVENANT SPECIFIED IN THIS SECTION, BUT VERY RIGHT AND REMEDY OF ANY SUCH PERSON, IN CONTRACT OR TORT, FOR OR ON ACCOUNT OF ANY SUCH BREACH SHALL BE LIMITED TO AN ACTION FOR MANDAMUS OR SPECIFIC PERFORMANCE.

No default by the Issuer in observing or performing its obligations under this Section shall comprise a breach of or default under this Resolution for purposes of any other provision of this Resolution.

Nothing in this Section is intended or shall act to disclaim, waive, or otherwise limit the duties of the Issuer under federal and state securities laws.

The provisions of this Section may be amended by the Issuer from time to time to adapt to changed circumstances that arise from a change in legal requirements, a change in law, or a change in the identify, nature, status, or type of operations of the City, but only if (1) the provisions of this Section, as so amended, would have permitted an underwriter to purchase or sell Series 2015 Bonds in the primary offering of the Series 2015 Bonds in compliance with the Rule, taking into account any amendments or interpretations of the Rule since such offering as well s such changed circumstances and (2) either (a) the Holders of a majority in aggregate principal amount (or any greater amount required by any other provision of this Resolution that authorizes such an amendment) of the outstanding Series 2015 Bonds consent to such amendment or (b) a Person that is unaffiliated with the Issuer (such as nationally recognized bond counsel) determined that such amendment will not materially impair the interest of the Holders and beneficial owners of the Series 2015 Bonds. If the Issuer so amends the provisions of this Section, it shall include, or cause the City to include, with any amended financial information or operating data next provided in accordance with Subsection (a) hereof an explanation, in narrative form, of the reason for the amendment and of the impact of any change in the type of financial information or operating data so provided. The Issuer may also amend or repeal the provisions of this continuing disclosure agreement if the SEC amends or repeals the applicable provision of the Rule or a court of final jurisdiction enters judgment that such provisions of the Rule are invalid, but only if and to the extent that the provisions of this sentence would not prevent an underwriter from lawfully purchasing or selling Series 2015 Bonds in the primary offering of the Series 2015 Bonds.

(d) Definitions.

As used in this Section, the following terms have the meanings ascribed to such terms below:

"*MSRB*" means the Municipal Securities Rulemaking Board.

"*Rule*" means SEC Rule 15c2-12, as amended from time to time.

"*SEC*" means the United States Securities and Exchange Commission and any successor to its duties.

Section 39. REPEAL OF CONFLICTING RESOLUTIONS. All resolutions and all parts of any resolutions which are in conflict or inconsistent with this Resolution are hereby repealed and shall be of no further force or effect to the extent of such conflict or inconsistency.

Section 40. PUBLIC NOTICE. It is hereby officially found and determined that public notice of the time, place and purpose of said meeting was given, all as required by the Government Code, Chapter 551.

EXHIBIT A

WRITTEN PROCEDURES RELATING TO CONTINUING
COMPLIANCE WITH FEDERAL TAX COVENANTS

A. Arbitrage. With respect to the investment and expenditure of the proceeds of the Bonds (the "Obligations") the Issuer's General Manager, Assistant General Manager, and Finance Director (the "Responsible Persons") will :

For Obligations issued for newly acquired property or constructed property:

- instruct the appropriate person or persons that the construction, renovation or acquisition of the facilities must proceed with due diligence and that binding contracts for the expenditure of at least 5%of the proceeds of the Obligations will be entered into within 6 months of the Issue Date;
- monitor that at least 85% of the proceeds of the Obligations to be used for the construction, renovation or acquisition of any facilities are expended within 3 years of the date of delivery of the Obligations ("Issue Date");
- restrict the yield of the investments (other than those in the Reserve Fund) to the yield on the Obligations after 3 years of the Issue Date;
- monitor all amounts deposited into a sinking fund or funds, e.g., the Interest and Redemption Fund and the Reserve Fund, to assure that the maximum amount invested at a yield higher than the yield on the Obligations does not exceed an amount equal to the debt service on the Obligations in the succeeding 12 month period plus a carryover amount equal to one-twelfth of the principal and interest payable on the Obligations for the immediately preceding 12-month period;
- assure that no more than 50% of the proceeds of the Obligations are invested in an investment with a guaranteed yield for 4 years or more;
- assure that the maximum amount of the Reserve Fund invested at a yield higher than the yield on the Obligations will not exceed the lesser of (1) 10% of the original principal amount of the Obligations, (2) 125% of the average annual debt service on the Obligations measured as of the Issue Date, or (3) 100% of the maximum annual debt service on the Obligations as of the Issue Date;

For Obligations issued for refunding purposes:

- monitor the actions of the escrow agent (to the extent an escrow is funded with proceeds) to assure compliance with the applicable provisions of the escrow agreement, including with respect to reinvestment of cash balances;

For all Obligations:

- maintain any official action of the Issuer (such as a reimbursement resolution) stating its intent to reimburse itself or the City with the proceeds of the Obligations any amount expended prior to the Issue Date for the acquisition, renovation or construction of the facilities;

- assure that the applicable information return (e.g., IRS Form 8038-G, 8038-GC, or any successor forms) is timely filed with the IRS;

- assure that, unless excepted from rebate and yield restriction under section 148(f) of the Code, excess investment earnings are computed and paid to the U.S. government at such time and in such manner as directed by the IRS (i) at least every 5 years after the Issue Date and (ii) within 30 days after the date the Obligations are retired.

B. Private Business Use. With respect to the use of the facilities financed or refinanced with the proceeds of the Obligations the Responsible Persons will:

- monitor the date on which the facilities are substantially complete and available to be used for the purpose intended;

- monitor whether, at any time the Obligations are outstanding, any person, other than the Issuer or the City, the employees of the Issuer or the City, the agents of the Issuer or the City or members of the general public has any contractual right (such as a lease, purchase, management or other service agreement) with respect to any portion of the facilities;

- monitor whether, at any time the Obligations are outstanding, any person, other than the Issuer or the City, the employees of the Issuer or the City, the agents of the Issuer or the City or members of the general public has a right to use the output of the facilities (e.g., water, gas, electricity);

- monitor whether, at any time the Obligations are outstanding, any person, other than the Issuer or the City, the employees of the Issuer or the City, the agents of the Issuer or the City or members of the general public has a right to use the facilities to conduct or to direct the conduct of research;

- determine whether, at any time the Obligations are outstanding, any person, other than the Issuer or the City, has a naming right for the facilities or any other contractual right granting an intangible benefit;

- determine whether, at any time the Obligations are outstanding, the facilities are sold or otherwise disposed of; and

- take such action as is necessary to remediate any failure to maintain compliance with the covenants contained in the resolution authorizing the Obligations.

C. Record Retention. The Responsible Persons will maintain or cause to be maintained all records relating to the investment and expenditure of the proceeds of the Obligations and the use of the facilities financed or refinanced thereby for a period ending three (3) years after the complete extinguishment of the Obligations. If any portion of the Obligations is refunded with the proceeds of another series of tax-exempt obligations, such records shall be maintained until the three (3) years after the refunding obligations are completely extinguished. Such records can be maintained in paper or electronic format.

D. Responsible Persons. Each Responsible Person shall receive appropriate training regarding the Issuer's accounting system, contract intake system, facilities management and other systems necessary to track the investment and expenditure of the proceeds and the use of the facilities financed with the proceeds of the Obligations. The foregoing notwithstanding, the Responsible Persons are authorized and instructed to retain such experienced advisors and agents as may be necessary to carry out the purposes of these instructions.

EXHIBIT B

DESCRIPTION OF ANNUAL FINANCIAL INFORMATION

The following information is referred to in Section 38 of this Resolution.

I. Annual Financial Statements and Operating Data

The financial information and operating data with respect to the Issuer to be provided annually in accordance with such Section are as specified below:

Accounting Principles

The accounting principles referred to in such Section are the accounting principles described in the notes to the financial statements referred to in paragraph 1 above.

EXHIBIT "C"

ESCROW AGREEMENT

RESOLUTION AUTHORIZING THE ISSUANCE, SALE, AND DELIVERY OF TARRANT REGIONAL WATER DISTRICT, A WATER CONTROL AND IMPROVEMENT DISTRICT, WATER REVENUE BONDS, SERIES 2015A, PLEDGING REVENUES FOR THE PAYMENT OF THE BONDS, AND AUTHORIZING OTHER INSTRUMENTS AND PROCEDURES RELATING THERETO

THE STATE OF TEXAS	§
COUNTY OF TARRANT	§
TARRANT REGIONAL WATER DISTRICT A WATER CONTROL AND IMPROVEMENT DISTRICT	§

WHEREAS, Tarrant Regional Water District, a Water Control and Improvement District, (formerly known as "Tarrant County Water Control and Improvement District Number One") (the "Issuer" or the "District") is a political subdivision of the State of Texas, being a conservation and reclamation district created and functioning under Article 16, Section 59, of the Texas Constitution, pursuant to the general laws of the State of Texas, including Chapters 49 and 51, Texas Water Code, and pursuant to the provisions of Chapter 268, Acts of 1957, 55th Legislature of Texas, Regular Session, as amended (collectively the "District Act"); and

WHEREAS, the Issuer will authorize the Series 2015A Bonds (hereinafter defined) pursuant to the District Act; and

WHEREAS, by adoption of its Resolution Approving an Application for Financial Assistance, dated _____, 2015, the Texas Water Development Board ("TWDB") has agreed to purchase the Issuer's hereinafter authorized bonds; and

WHEREAS, the meeting was open to the public and public notice of the time, place and purpose of said meeting was given pursuant to Chapter 551, Texas Government Code.

THEREFORE, BE IT RESOLVED BY THE BOARD OF DIRECTORS OF TARRANT REGIONAL WATER DISTRICT, A WATER CONTROL AND IMPROVEMENT DISTRICT, THAT:

Section 1. AMOUNT AND PURPOSE OF THE BONDS. The Bonds will be issued in one or more series, in an aggregate principal amount not to exceed $300,000,000, and in the manner hereinafter provided, for the purpose of obtaining funds (i) to pay for construction, improvements, and extensions to the District's Water System, including design, acquisition, and construction of an integrated pipeline to serve the City of Dallas and the District; (ii) to fund a debt service reserve fund; and (iii) to pay costs of issuance of the Series 2015A Bonds.

Section 2. DESIGNATION OF THE BONDS. Each bond issued pursuant to this Resolution shall be designated: "TARRANT REGIONAL WATER DISTRICT, A WATER CONTROL AND IMPROVEMENT DISTRICT, WATER REVENUE BOND, SERIES 2015A." Initially there shall be issued, sold, and delivered hereunder a single fully registered bond, without interest coupons, payable in installments of principal (the "Initial Bond"), but the Initial Bond may

be assigned and transferred and/or converted into and exchanged for a like aggregate amount of fully registered bonds, without interest coupons, having serial maturities, and in the denomination or denominations of $5,000 or any integral multiple of $5,000, all in the manner hereinafter provided. The term "Series 2015A Bonds" as used in this Resolution shall mean and include collectively the Initial Bond and all substitute bonds exchanged therefor, as well as all other substitute bonds and replacement bonds issued pursuant hereto, and the term "Series 2015A Bond" shall mean any of the Series 2015A Bonds.

Section 3. INITIAL DATE, DENOMINATION, NUMBER, MATURITIES, INITIAL REGISTERED OWNER, AND CHARACTERISTICS OF THE INITIAL BOND. (a) The Initial Bond is hereby authorized to be issued, sold, and delivered hereunder as a single fully registered Bond, without interest coupons, dated _____, 2015, in the denomination and aggregate principal amount of $_____, numbered TR-1, payable in annual installments of principal to the initial registered owner thereof, to-wit: Texas Water Development Board or to the registered assignee or assignees of said Initial Bond or any portion or portions thereof (in each case, the "registered owner"), with the annual installments of principal of the Initial Bond to be payable on the dates, respectively, and in the principal amounts, respectively, stated in the FORM OF INITIAL BOND set forth in this Resolution.

(b) The Initial Bond (i) may be prepaid or paid on the respective scheduled due dates of installments of principal thereof, (ii) may be assigned and transferred, (iii) may be converted and exchanged for other bonds, (iv) shall have the characteristics, and (v) shall be signed and sealed, and the principal of and interest on the Initial Bond shall be payable, all as provided, and in the manner required or indicated, in the FORM OF INITIAL BOND set forth in this Resolution.

Section 4. INTEREST. The unpaid principal balance of the Initial Bond shall bear interest from the date of delivery (the "Issue Date") of the Initial Bond to the TWDB to the respective scheduled due dates, or to the respective dates of prepayment or redemption, if any, of the installments of principal of the Initial Bond, and such interest shall be payable in the manner, at the rates, and on the dates, respectively, as provided in the FORM OF INITIAL BOND set forth in this Resolution.

Section 5. FORM OF INITIAL BOND. The form of the Initial Bond, including the form of Registration Certificate of the Comptroller of Public Accounts of the State of Texas to be endorsed on the Initial Bond, shall be substantially as fol1ows:

FORM OF INITIAL BOND

NO. TR-1 $_____

UNITED STATES OF AMERICA
STATE OF TEXAS
TARRANT REGIONAL WATER DISTRICT,
A WATER CONTROL AND IMPROVEMENT DISTRICT,
WATER REVENUE BOND,
SERIES 2015A

TARRANT REGIONAL WATER DISTRICT, A WATER CONTROL AND IMPROVEMENT DISTRICT (the "Issuer"), being a political subdivision of the State of Texas, hereby promises to pay to TEXAS WATER DEVELOPMENT BOARD (the "TWDB") or to the registered assignee or assignees of this Bond or any portion or portions hereof (in each case, the "registered owner") the aggregate principal amount of _____ _____ in annual installments of principal due and payable on March 1 in each of the years, and in the respective principal amounts, as set forth in the following schedule:

Year	Principal Amount	Year	Principal Amount

and to pay interest, calculated on the basis of a 360-day year composed of twelve 30-day months, from the date of initial delivery of this Bond to the TWDB, on the balance of each such installment of principal, respectively, from time to time remaining unpaid, at the rates as follows:

Year	Rate	Year	Rate

with said interest being payable semiannually on each March 1 and September 1, commencing _____, while this Bond or any portion hereof is outstanding and unpaid.

THE INSTALLMENTS OF PRINCIPAL OF AND THE INTEREST ON this Bond are payable in lawful money of the United States of America, without exchange or collection charges. The installments of principal and the interest on this Bond are payable to the registered owner hereof through the services of BOFK, NA d/b/a Bank of Texas, DALLAS, TEXAS, which is the "Paying Agent/Registrar" for this Bond. Payment of all principal of and interest on this Bond shall be made by the Paying Agent/Registrar to the registered owner hereof on each principal and/or interest payment date by check, dated as of such date, drawn by the Paying Agent/Registrar on, and payable solely from, funds of the Issuer required by the resolution authorizing the issuance of this Bond (the "Bond Resolution") to be on deposit with the Paying Agent/Registrar for such purpose as hereinafter provided; and such check shall be sent by the Paying Agent/Registrar by United States mail, first-class postage prepaid, on each such principal and/or interest payment date, to the registered owner hereof, at the address of the registered owner, as it appeared at the close of business on the 15th day of the month next preceding each such date (the "Record Date") on the Registration Books kept by the Paying Agent/ Registrar, as hereinafter described; provided that, if the TWDB is the registered

owner of this Bond, at the option of the TWDB and at the expense of the Issuer, such payment shall be made by wire transfer pursuant to written directions of the TWDB. The Issuer covenants with the registered owner of this Bond that on or before each principal and/or interest payment date for this Bond it will make available to the Paying Agent/Registrar, from the "Interest and Redemption Fund" created by the Bond Resolution, the amounts required to provide for the payment, in immediately available funds, of all principal of and interest on this Bond, when due.

IF THE DATE for the payment of the principal of or interest on this Bond shall be a Saturday, Sunday, a legal holiday, or a day on which banking institutions in the City where the Paying Agent/Registrar is located are authorized by law or executive order to close, then the date for such payment shall be the next succeeding day which is not such a Saturday, Sunday, legal holiday, or day on which banking institutions are authorized to close; and payment on such date shall have the same force and effect as if made on the original date payment was due.

THIS BOND has been authorized in accordance with the Constitution and laws of the State of Texas in the principal amount of $_____, for the purpose of obtaining funds (i) (i) to pay for construction, improvements, and extensions to the District's Water System, including design, acquisition, and construction of an integrated pipeline to serve the City of Dallas and the District; (ii) to fund a debt service reserve fund; and (iii) to pay costs of issuance of the Series 2015A Bonds.

ON _____ 1, ____, or any date thereafter, the unpaid installments of principal of this Bond may be prepaid or redeemed prior to their scheduled due dates, at the option of the Issuer, with funds derived from any available source, as a whole, or in part, and, if in part, in inverse order of maturity and if less than a whole principal installment is to be called, the Issuer shall direct the Paying Agent/Registrar to call by lot or other customary method of random selection the portion of the principal installment to be redeemed (only in an integral multiple of $5,000), at the redemption price of the principal amount to be prepaid or redeemed, plus accrued interest to the date fixed for prepayment or redemption.

AT LEAST 30 days prior to the date fixed for any such prepayment or redemption a written notice of such prepayment or redemption shall be mailed by the Paying Agent/Registrar to the registered owner hereof. By the date fixed for any such prepayment or redemption due provision shall be made by the Issuer with the Paying Agent/Registrar for the payment of the required prepayment or redemption price for this Bond or the portion hereof which is to be so prepaid or redeemed, plus accrued interest thereon to the date fixed for prepayment or redemption. If such written notice of prepayment or redemption is given, and if due provision for such payment is made, all as provided above, this Bond, or the portion thereof which is to be so prepaid or redeemed, thereby automatically shall be treated as prepaid or redeemed prior to its scheduled due date, and shall not bear interest after the date fixed for its prepayment or redemption, and shall not be regarded as being outstanding except for the right of the registered owner to receive the prepayment or redemption price plus accrued interest to the date fixed for prepayment or redemption from the Paying Agent/Registrar out of the funds provided for such payment. The Paying Agent/Registrar shall record in the Registration Books all such prepayments or redemptions of principal of this Bond or any portion hereof.

THIS BOND, to the extent of the unpaid principal balance hereof, or any unpaid portion hereof in any integral multiple of $5,000, may be assigned by the initial registered owner hereof and shall be transferred only in the Registration Books of the Issuer kept by the Paying Agent/Registrar acting in the capacity of registrar for the Bonds, upon the terms and conditions set forth in the Bond Resolution. Among other requirements for such transfer, this Bond must be presented and surrendered to the Paying Agent/ Registrar for cancellation, together with proper instruments of assignment, in form and with guarantee of signatures satisfactory to the Paying Agent/Registrar, evidencing assignment by the initial registered owner of this Bond, or any portion or portions hereof in any integral multiple of $5,000, to the assignee or assignees in whose name or names this Bond or any such portion or portions hereof is or are to be transferred and registered. Any instrument or instruments of assignment satisfactory to the Paying Agent/Registrar may be used to evidence the assignment of this Bond or any such portion or portions hereof by the initial registered owner hereof. A new bond or bonds payable to such assignee or assignees (which then will be the new registered owner or owners of such new Bond or Bonds) or to the initial registered owner as to any portion of this Bond which is not being assigned and transferred by the initial registered owner, shall be delivered by the Paying Agent/Registrar in conversion of and exchange for this Bond or any portion or portions hereof, but solely in the form and manner as provided in the next paragraph hereof for the conversion and exchange of this Bond or any portion hereof. The registered owner of this Bond shall be deemed and treated by the Issuer and the Paying Agent/Registrar as the absolute owner hereof for all purposes, including payment and discharge of liability upon this Bond to the extent of such payment, and the Issuer and the Paying Agent/Registrar shall not be affected by any notice to the contrary.

AS PROVIDED above and in the Bond Resolution, this Bond, to the extent of the unpaid principal balance hereof, may be converted into and exchanged for a like aggregate principal amount of fully registered bonds, without interest coupons, payable to the assignee or assignees duly designated in writing by the initial registered owner hereof, or to the initial registered owner as to any portion of this Bond which is not being assigned and transferred by the initial registered owner, in any denomination or denominations in any integral multiple of $5,000 (subject to the requirement hereinafter stated that each substitute bond issued in exchange for any portion of this Bond shall have a single stated principal maturity date), upon surrender of this Bond to the Paying Agent/Registrar for cancellation, all in accordance with the form and procedures set forth in the Bond Resolution. If this Bond or any portion hereof is assigned and transferred or converted each bond issued in exchange for any portion hereof shall have a single stated principal maturity date corresponding to the due date of the installment of principal of this Bond or portion hereof for which the substitute bond is being exchanged, and shall bear interest at the rate applicable to and borne by such installment of principal or portion thereof. Such bonds, respectively, shall be subject to redemption prior to maturity on the same dates and for the same prices as the corresponding installment of principal of this Bond or portion hereof for which they are being exchanged. No such bond shall be payable in installments, but shall have only one stated principal maturity date. AS PROVIDED IN THE BOND RESOLUTION, THIS BOND IN ITS PRESENT FORM MAY BE ASSIGNED AND TRANSFERRED OR CONVERTED ONCE ONLY, and to one or more assignees, but the bonds issued and delivered in exchange for this Bond or any portion hereof may be assigned and transferred, and converted, subsequently, as provided in the Bond Resolution. The Issuer shall pay the Paying Agent/Registrar's standard or customary fees and charges for transferring, converting, and exchanging this Bond or any portion thereof, but the one requesting

such transfer, conversion, and exchange shall pay any taxes or governmental charges required to be paid with respect thereto. The Paying Agent/Registrar shall not be required to make any such assignment, conversion, or exchange (i) during the period commencing with the close of business on any Record Date and ending with the opening of business on the next following principal or interest payment date, or, (ii) with respect to any Bond or portion thereof called for prepayment or redemption prior to maturity, within 45 days prior to its prepayment or redemption date.

IN THE EVENT any Paying Agent/Registrar for this Bond is changed by the Issuer, resigns, or otherwise ceases to act as such, the Issuer has covenanted in the Bond Resolution that it promptly will appoint a competent and legally qualified substitute therefor, and promptly will cause written notice thereof to be mailed to the registered owner of this Bond.

IT IS HEREBY certified, recited, and covenanted that this Bond has been duly and validly authorized, issued, and delivered; that all acts, conditions, and things required or proper to be performed, exist, and be done precedent to or in the authorization, issuance, and delivery of this Bond have been performed, existed, and been done in accordance with law; that this Bond and the interest thereon, are special obligations of the Issuer which, together with other outstanding bonds of the Issuer, are secured by and payable equally and ratably on a parity from a first lien on and pledge of the "Pledged Revenues," as defined in the Bond Resolution, which include the "Net Revenues of the District's Water System," as defined in the Bond Resolution, which specifically include certain amounts to be received by the Issuer (i) pursuant to the "Tarrant County Regional Water Supply Facilities Contract," dated August 29, 1979, among the Issuer and the Cities of Fort Worth and Mansfield, Texas, the "Tarrant County Regional Water Supply Facilities Supplemental Contract For Trinity River Authority of Texas," dated as of March 12, 1979 between the Issuer and Trinity River Authority of Texas, and the "Tarrant County Regional Water Supply Facilities Amendatory Contract", dated September 1, 1982, among the Issuer, the Cities of Fort Worth, Arlington, and Mansfield, Texas, and Trinity River Authority of Texas, which last named amendatory contract consolidates the previous contracts between such parties with respect to the Issuer's Water System into one instrument and sets forth the entire agreement between such parties with respect to the Issuer's Water System, and (ii) pursuant to contracts with other water customers of the Issuer.

THE ISSUER has reserved the right, subject to the restrictions stated in the Bond Resolution, to issue Additional Bonds payable from and secured by a first lien on and pledge of the "Pledged Revenues" on a parity with this Bond.

THE ISSUER also has reserved the right to amend the Bond Resolution, with the approval of the owners of 51% of the outstanding bonds secured by a first lien on the Pledged Revenues, subject to the restrictions as stated in the Bond Resolution.

THE REGISTERED OWNER hereof shall never have the right to demand payment of this Bond or the interest hereon out of any funds raised or to be raised by taxation or from any source whatsoever other than specified in the Bond Resolution.

BY BECOMING the registered owner of this Bond, the registered owner thereby acknowledges all of the terms and provisions of the Bond Resolution, agrees to be bound by such

terms and provisions, acknowledges that the Bond Resolution is duly recorded and available for inspection in the official minutes and records of the governing body of the Issuer, and agrees that the terms and provisions of this Bond and the Bond Resolution constitute a contract between the registered owner hereof and the Issuer.

IN WITNESS WHEREOF, the Issuer has caused this Bond to be signed with the manual or facsimile signature of the President of the Board of Directors of the Issuer and countersigned with the manual or facsimile signature of the Secretary of the Board of Directors of the Issuer, has caused the official seal of the Issuer to be duly impressed, or placed in facsimile, on this Bond and has caused this Bond to be dated as of _____, 2015.

xxxxxxx	xxxxxxx
Secretary, Board of Directors	President, Board of Directors

(DISTRICT SEAL)

FORM OF REGISTRATION CERTIFICATE OF THE
COMPTROLLER OF PUBLIC ACCOUNTS:

COMPTROLLER'S REGISTRATION CERTIFICATE: REGISTER NO.

I hereby certify that this Bond has been examined, certified as to validity, and approved by the Attorney General of the State of Texas, and that this Bond has been registered by the Comptroller of Public Accounts of the State of Texas.

Witness my signature and seal this

_____
Comptroller of Public Accounts of the State of Texas

(COMPTROLLER'S SEAL)

Section 6. CHARACTERISTICS OF THE SERIES 2015A BONDS. (a) Registration, Transfer, Conversion and Exchange; Authentication. (a) The Issuer shall keep or cause to be kept at the principal corporate trust office of BOFK, NA d/b/a Bank of Texas, Dallas, Texas (the "Paying Agent/Registrar") books or records for the registration of the transfer, conversion and exchange of the Series 2015A Bonds (the "Registration Books"), and the Issuer hereby appoints the Paying Agent/Registrar as its registrar and transfer agent to keep such books or records and make such registrations of transfers, conversions and exchanges under such reasonable regulations as the Issuer and Paying Agent/Registrar may prescribe; and the Paying Agent/Registrar shall make such registrations, transfers, conversions and exchanges as herein provided. The Paying Agent/Registrar shall obtain and record in the Registration Books the address of the registered owner of each Series 2015A Bond to which payments with respect to the Series 2015A Bonds shall be mailed, as herein provided; but it shall be the duty of each registered owner to notify the Paying Agent/Registrar in writing of the address to which payments shall be mailed, and such interest payments shall not be mailed unless such notice has been given. To the extent possible and under reasonable

circumstances, all transfers of Series 2015A Bonds shall be made within three business days after request and presentation thereof. The Issuer shall have the right to inspect the Registration Books during regular business hours of the Paying Agent/Registrar, but otherwise the Paying Agent/Registrar shall keep the Registration Books confidential and, unless otherwise required by law, shall not permit their inspection by any other entity. The Paying Agent/Registrar's standard or customary fees and charges for making such registration, transfer, conversion, exchange and delivery of a substitute Series 2015A Bond or Series 2015A Bonds shall be paid as provided in the FORM OF SERIES 2015A BOND set forth in this Resolution. Registration of assignments, transfers, conversions and exchanges of Series 2015 Bonds shall be made in the manner provided and with the effect stated in the FORM OF SERIES 2015A BOND set forth in this Resolution. Each substitute Series 2015A Bond shall bear a letter and/or number to distinguish it from each other Series 2015A Bond.

An authorized representative of the Paying Agent/Registrar shall, before the delivery of any such Series 2015A Bond, date and manually sign the Paying Agent/Registrar's Authentication Certificate, and no such Series 2015A Bond shall be deemed to be issued or outstanding unless such Certificate is so executed. The Paying Agent/Registrar promptly shall cancel all paid Series 2015A Bonds surrendered for conversion and exchange. No additional ordinances, orders, or resolutions need be passed or adopted by the governing body of the Issuer or any other body or person so as to accomplish the foregoing conversion and exchange of any Series 2015A Bond or portion thereof, and the Paying Agent/Registrar shall provide for the printing, execution, and delivery of the substitute Series 2015A Bonds in the manner prescribed herein, and said Series 2015A Bonds shall be of type composition printed on paper of customary weight and strength. Pursuant to Subchapter D, Chapter 1201, Texas Government Code, the duty of conversion and exchange of Series 2015A Bonds as aforesaid is hereby imposed upon the Paying Agent/Registrar, and, upon the execution of said Certificate, the converted and exchanged Series 2015A Bond shall be valid, incontestable, and enforceable in the same manner and with the same effect as the Series 2015A Bonds which initially were issued and delivered pursuant to this Resolution, approved by the Attorney General, and registered by the Comptroller of Public Accounts.

(b) Payment of Series 2015A Bonds and Interest. The Issuer hereby further appoints the Paying Agent/Registrar to act as the paying agent for paying the principal of and interest on the Series 2015A Bonds, all as provided in this Resolution. The Paying Agent/Registrar shall keep proper records of all payments made by the Issuer and the Paying Agent/Registrar with respect to the Series 2015A Bonds.

(c) In General. The Series 2015A Bonds (i) shall be issued in fully registered form, without interest coupons, with the principal of and interest on such Series 2015A Bonds to be payable only to the registered owners thereof, (ii) may be redeemed prior to their scheduled maturities, (iii) may be transferred and assigned, (iv) may be converted and exchanged for other Series 2015A Bonds, (v) shall have the characteristics, (vi) shall be signed, sealed, executed and authenticated, (vii) shall be payable as to principal and interest, and (viii) shall be administered and the Paying Agent/Registrar and the Issuer shall have certain duties and responsibilities with respect to the Series 2015A Bonds, all as provided, and in the manner and to the effect as required or indicated, in the FORM OF SERIES 2015A BOND set forth in this Resolution. The Series 2015A Bonds initially issued and delivered pursuant to this Resolution are not required to be, and shall not be,

authenticated by the Paying Agent/Registrar, but on each substitute Series 2015A Bond issued in conversion of and exchange for any Series 2015A Bond or Series 2015A Bonds issued under this Resolution the Paying Agent/Registrar shall execute the PAYING AGENT/REGISTRAR'S AUTHENTICATION CERTIFICATE, in the form set forth in the FORM OF SERIES 2015A BOND.

(d) Substitute Paying Agent/Registrar. The Issuer covenants with the registered owners of the Series 2015A Bonds that at all times while the Series 2015A Bonds are outstanding the Issuer will provide a competent and legally qualified bank, trust company, financial institution, or other agency to act as and perform the services of Paying Agent/Registrar for the Series 2015A Bonds under this Resolution, and that the Paying Agent/Registrar will be one entity. The Issuer reserves the right to, and may, at its option, change the Paying Agent/Registrar upon not less than 120 days written notice to the Paying Agent/Registrar, to be effective not later than 60 days prior to the next principal or interest payment date after such notice. In the event that the entity at any time acting as Paying Agent/Registrar (or its successor by merger, acquisition, or other method) should resign or otherwise cease to act as such, the Issuer covenants that promptly it will appoint a competent and legally qualified bank, trust company, financial institution, or other agency to act as Paying Agent/Registrar under this Resolution. Upon any change in the Paying Agent/Registrar, the previous Paying Agent/Registrar promptly shall transfer and deliver the Registration Books (or a copy thereof), along with all other pertinent books and records relating to the Series 2015A Bonds, to the new Paying Agent/Registrar designated and appointed by the Issuer. Upon any change in the Paying Agent/Registrar, the Issuer promptly will cause a written notice thereof to be sent by the new Paying Agent/Registrar to each registered owner of the Series 2015A Bonds, by United States mail, first-class postage prepaid, which notice also shall give the address of the new Paying Agent/Registrar. By accepting the position and performing as such, each Paying Agent/Registrar shall be deemed to have agreed to the provisions of this Resolution, and a certified copy of this Resolution shall be delivered to each Paying Agent/Registrar.

(e) Reporting Requirements of Paying Agent/Registrar. To the extent required by the Code and the regulations promulgated and pertaining thereto, it shall be the duty of the Paying Agent/Registrar, on behalf of the Issuer, to report to the owners of the Series 2015A Bonds and the Internal Revenue Service (i) the amount of "reportable payments," if any, subject to backup withholding during each year and the amount of tax withheld, if any, with respect to payments of the Series 2015A Bonds and (ii) the amount of interest or amount treated as interest on the Series 2015A Bonds and required to be included in gross income of the owner thereof.

(f) Book-Entry Only System. The Series 2015A Bonds issued in exchange for the Initial Bond shall be initially issued in the form of a separate single fully registered Series 2015A Bond for each of the maturities thereof. Upon initial issuance, the ownership of each such Series 2015A Bond shall be registered in the name of Cede & Co., as nominee of Depository Trust Company of New York ("DTC"), and except as provided in subsection (f) hereof, all of the outstanding Series 2015A Bonds shall be registered in the name of Cede & Co., as nominee of DTC.

With respect to Series 2015A Bonds registered in the name of Cede & Co., as nominee of DTC, the Issuer and the Paying Agent/Registrar shall have no responsibility or obligation to any DTC Participant or to any person on behalf of whom such a DTC Participant holds an interest on

the Series 2015A Bonds. Without limiting the immediately preceding sentence, the Issuer and the Paying Agent/Registrar shall have no responsibility or obligation with respect to (i) the accuracy of the records of DTC, Cede & Co. or any DTC Participant with respect to any ownership interest in the Series 2015A Bonds, (ii) the delivery to any DTC Participant or any other person, other than a Bondholder, as shown on the Registration Books, of any notice with respect to the Series 2015A Bonds, including any notice of redemption, or (iii) the payment to any DTC Participant or any other person, other than a Bondholder, as shown in the Registration Books of any amount with respect to principal of, premium, if any, or interest on, as the case may be, the Series 2015A Bonds. Notwithstanding any other provision of this Resolution to the contrary, the Issuer and the Paying Agent/Registrar shall be entitled to treat and consider the person in whose name each Series 2015A Bond is registered in the Registration Books as the absolute owner of such Series 2015A Bond for the purpose of payment of principal, premium, if any, and interest, as the case may be, with respect to such Series 2015A Bond, for the purpose of giving notices of redemption and other matters with respect to such Series 2015A Bond, for the purpose of registering transfers with respect to such Series 2015A Bond, and for all other purposes whatsoever. The Paying Agent/Registrar shall pay all principal of and interest on the Series 2015A Bonds only to or upon the order of the respective owners, as shown in the Registration Books as provided in this Resolution, or their respective attorneys duly authorized in writing, and all such payments shall be valid and effective to fully satisfy and discharge the Issuer's obligations with respect to payment of principal of, premium, if any, and interest on, or as the case may be, the Series 2015A Bonds to the extent of the sum or sums so paid. No person other than an owner, as shown in the Registration Books, shall receive a Series 2015A Bond certificate evidencing the obligation of the Issuer to make payments of principal, premium, if any, and interest, as the case may be, pursuant to this Resolution. Upon delivery by DTC to the Paying Agent/Registrar of written notice to the effect that DTC has determined to substitute a new nominee in place of Cede & Co., and subject to the provisions in this Resolution with respect to interest checks being mailed to the registered owner at the close of business on the Record Date, the word "Cede & Co." in this Resolution shall refer to such new nominee of DTC.

(g) Successor Securities Depository; Transfers Outside Book-Entry Only System. In the event that the Issuer or the Paying Agent/Registrar determines that DTC is incapable of discharging its responsibilities described herein and in the representation letter of the Issuer to DTC and that it is in the best interest of the beneficial owners of the Series 2015A Bonds that they be able to obtain certificated Series 2015A Bonds, the Issuer or the Paying Agent/Registrar shall (i) appoint a successor securities depository, qualified to act as such under Section 17(a) of the Securities and Exchange Act of 1934, as amended, notify DTC and DTC Participants of the appointment of such successor securities depository and transfer one or more separate Series 2015A Bonds to such successor securities depository or (ii) notify DTC and DTC Participants of the availability through DTC of Series 2015A Bonds and transfer one or more separate Series 2015A Bonds to DTC Participants having Series 2015A Bonds credited to their DTC accounts. In such event, the Series 2015A Bonds shall no longer be restricted to being registered in the Registration Books in the name of Cede & Co., as nominee of DTC, but may be registered in the name of the successor securities depository, or its nominee, or in whatever name or names Bondholders transferring or exchanging Series 2015A Bonds shall designate, in accordance with the provisions of this Resolution.

(h) Payments to Cede & Co. Notwithstanding any other provision of this Resolution to the contrary, so long as any Series 2015A Bond is registered in the name of Cede & Co., as nominee

of DTC, all payments with respect to principal of, premium, if any, and interest on, or as the case may be, such Series 2015A Bond and all notices with respect to such Series 2015A Bond shall be made and given, respectively, in the manner provided in the representation letter of the Issuer to DTC.

Section 7. FORM OF SERIES 2015A SUBSTITUTE BONDS. The form of all Series 2015A Bonds issued in conversion and exchange or replacement of any other Series 2015A Bond or portion thereof, including the form of Paying Agent/Registrar's Certificate to be printed on each of such Series 2015A Bonds, and the Form of Assignment to be printed on each of the Series 2015A Bonds, shall be, respectively, substantially as follows, with such appropriate variations, omissions, or insertions as are permitted or required by this Resolution.

FORM OF SERIES 2015A SUBSTITUTE BOND

NO.____ PRINCIPAL AMOUNT
$_____

UNITED STATES OF AMERICA
STATE OF TEXAS
TARRANT REGIONAL WATER DISTRICT,
A WATER CONTROL AND IMPROVEMENT DISTRICT,
WATER REVENUE BOND,
SERIES 2015A

INTEREST RATE	MATURITY DATE	ISSUE DATE	CUSIP NO.
%	March 1, ____	_____, 2015	

ON THE MATURITY DATE specified above TARRANT REGIONAL WATER DISTRICT, A WATER CONTROL AND IMPROVEMENT DISTRICT (the "Issuer"), being a political subdivision of the State of Texas, hereby promises to pay to CEDE & CO. or to the registered assignee hereof (either being hereinafter called the "registered owner") the principal amount of _____ DOLLARS and to pay interest thereon, calculated on the basis of a 360-day year composed of twelve 30-day months, from the Issue Date specified above, to the Maturity Date specified above, or the date of redemption prior to maturity, at the interest rate per annum specified above; with interest being payable semiannually on each March 1 and September 1, commencing _____, except that if the date of authentication of this Bond is later than the first Record Date (hereinafter defined), such principal amount shall bear interest from the interest payment date next preceding the date of authentication, unless such date of authentication is after any Record Date (hereinafter defined) but on or before the next following interest payment date, in which case such principal amount shall bear interest from such next following interest payment date.

THE PRINCIPAL OF AND INTEREST ON this Bond are payable in lawful money of the United States of America, without exchange or collection charges. The principal of this Bond shall

be paid to the registered owner hereof upon presentation and surrender of this Bond at maturity or upon the date fixed for its redemption prior to maturity, at the principal corporate trust office of BOFK, NA d/b/a Bank of Texas, Dallas, Texas, which is the "Paying Agent/Registrar" for this Bond. The payment of interest on this Bond shall be made by the Paying Agent/Registrar to the registered owner hereof on each interest payment date by check dated as of such interest payment date, drawn by the Paying Agent/Registrar on, and payable solely from, funds of the Issuer required by the resolution authorizing the issuance of the Bonds (the "Bond Resolution") to be on deposit with the Paying Agent/Registrar for such purpose as hereinafter provided; and such check shall be sent by the Paying Agent/Registrar by United States mail, first-class postage prepaid, on each such interest payment date, to the registered owner hereof, at the address of the registered owner, as it appeared at the close of business on the 15th day of the month next preceding each such date (the "Record Date") on the Registration Books kept by the Paying Agent/Registrar, as hereinafter described; provided, however, for Bonds, the registered owner of which is the Texas Water Development Board (the "TWDB"), at the option of the TWDB and at the expense of the Issuer, such payment shall be made by wire transfer pursuant to written directions of the TWDB. However, notwithstanding the foregoing provisions, (1) the payment of such interest may be made by any other method acceptable to the Paying Agent/Registrar and requested by, and at the risk and expense of, the registered owner hereof and (2) upon the written request, and at the risk and expense of, the registered owner of any Bond of this Series in the amount of $1,000,000 or more, delivered to the Paying Agent/Registrar not less than 15 days prior to any interest payment date, payment of the interest due on such Bond on such date shall be paid on such date by wire transfer to any designated account in the United States of America which has available to it the wire service facilities of the Federal Reserve Bank. Any accrued interest due upon the redemption of this Bond prior to maturity as provided herein shall be paid to the registered owner at the principal corporate trust office of the Paying Agent/Registrar upon presentation and surrender of this Bond for redemption and payment at the principal corporate trust office of the Paying Agent/Registrar. The Issuer covenants with the registered owner of this Bond that on or before each principal payment date, interest payment date, and accrued interest payment date for this Bond it will make available to the Paying Agent/Registrar, from the "Interest and Redemption Fund" created by the Bond Resolution, the amounts required to provide for the payment, in immediately available funds, of all principal of and interest on the Bonds, when due.

IF THE DATE for the payment of the principal of or interest on this Bond shall be a Saturday, Sunday, a legal holiday, or a day on which banking institutions in the City where the Paying Agent/Registrar is located are authorized by law or executive order to close, then the date for such payment shall be the next succeeding day which is not such a Saturday, Sunday, legal holiday, or day on which banking institutions are authorized to close; and payment on such date shall have the same force and effect as if made on the original date payment was due.

THIS BOND is one of an issue of bonds (the "Bonds") dated as of _____, 2015, authorized in accordance with the Constitution and laws of the State of Texas in the principal amount of $_____ for the purpose of obtaining funds (i) to pay for construction, improvements, and extensions to the District's Water System, including design, acquisition, and construction of an integrated pipeline to serve the City of Dallas and the District; (ii) to fund a debt service reserve fund; and (iii) to pay costs of issuance of the Bonds.

ON _____ 1, ____, or any date thereafter, the outstanding Bonds may be redeemed prior to their scheduled maturities, at the option of the Issuer, with funds derived from any available

source, as a whole, or in part, and, if in part, the Issuer shall select and designate the maturity, or maturities, and the amount that is to be redeemed, and if less than a whole maturity is to be redeemed, the Issuer shall direct the Paying Agent/Registrar to call by lot or other customary method of random selection the Bonds or portions thereof to be redeemed (provided that the Bonds to be redeemed only in integral multiples of $5,000), at the redemption price of the principal amount of the Bonds to be redeemed, plus accrued interest to the date fixed for redemption.

DURING ANY PERIOD in which ownership of the Bonds is determined by a book entry at a securities depository for the Bonds, if fewer than all of the Bonds of the same maturity and bearing the same interest rate are to be redeemed, the particular Bonds of such maturity and bearing such interest rate shall be selected in accordance with the arrangements between the Issuer and the securities depository.

AT LEAST 30 days prior to the date fixed for any redemption of Bonds or portions thereof prior to maturity at the option of the Issuer, a written notice of such redemption shall be sent by the Paying Agent/Registrar by United States mail, first-class postage prepaid, to the registered owner appearing on the Registration Books at the close of business on the day next preceding the date of mailing of such notice; provided, however, that any notice so mailed shall be conclusively presumed to have been duly given and the failure to receive such notice, or any defect therein shall not affect the validity or effectiveness of the proceedings for the redemption of any Bond at the option of the Issuer. By the date fixed for any such redemption due provision shall be made with the Paying Agent/Registrar for the payment of the required redemption price for the Bonds or portions thereof which are to be so redeemed, plus accrued interest thereon to the date fixed for redemption. If such written notice of redemption is mailed and if due provision for such payment is made, all as provided above, the Bonds or portions thereof which are to be so redeemed thereby automatically shall be treated as redeemed prior to their scheduled maturities, and they shall not bear interest after the date fixed for redemption, and they shall not be regarded as being outstanding except for the right of the registered owner to receive the redemption price plus accrued interest from the Paying Agent/Registrar out of the funds provided for such payment. If a portion of any Bond shall be redeemed a substitute Bond or Bonds having the same maturity date, bearing interest at the same rate, in any denomination or denominations in any integral multiple of $5,000, at the written request of the registered owner, and in aggregate principal amount equal to the unredeemed portion thereof, will be issued to the registered owner upon the surrender thereof for cancellation, at the expense of the Issuer, all as provided in the Bond Resolution.

THIS BOND OR ANY PORTION OR PORTIONS HEREOF IN ANY INTEGRAL MULTIPLE OF $5,000 may be assigned and shall be transferred only in the Registration Books of the Issuer kept by the Paying Agent/Registrar acting in the capacity of registrar for the Bonds, upon the terms and conditions set forth in the Bond Resolution. Among other requirements for such assignment and transfer, this Bond must be presented and surrendered to the Paying Agent/Registrar, together with proper instruments of assignment, in form and with guarantee of signatures satisfactory to the Paying Agent/Registrar, evidencing assignment of this Bond or any portion or portions hereof in any integral multiple of $5,000 to the assignee or assignees in whose name or names this Bond or any such portion or portions hereof is or are to be transferred and registered. The form of Assignment printed or endorsed on this Bond shall be executed by the registered owner or its duly authorized attorney or representative, to evidence the assignment hereof. A new Bond or Bonds payable to such assignee or assignees (which then will be the new registered owner or owners

of such new Bond or Bonds), or to the previous registered owner in the case of the assignment and transfer of only a portion of this Bond, may be delivered by the Paying Agent/Registrar in conversion of and exchange for this Bond, all in the form and manner as provided in the next paragraph hereof for the conversion and exchange of other Bonds. The Issuer shall pay the Paying Agent/Registrar's standard or customary fees and charges for making such transfer, but the one requesting such transfer shall pay any taxes or other governmental charges required to be paid with respect thereto. The Paying Agent/Registrar shall not be required to make transfers of registration of this Bond or any portion hereof (i) during the period commencing with the close of business on any Record Date and ending with the opening of business on the next following principal or interest payment date, or, (ii) with respect to any Bond or any portion thereof called for redemption prior to maturity, within 45 days prior to its redemption date. The registered owner of this Bond shall be deemed and treated by the Issuer and the Paying Agent/Registrar as the absolute owner hereof for all purposes, including payment and discharge of liability upon this Bond to the extent of such payment, and the Issuer and the Paying Agent/Registrar shall not be affected by any notice to the contrary.

ALL BONDS OF THIS SERIES are issuable solely as fully registered bonds, without interest coupons, in the denomination of any integral multiple of $5,000. As provided in the Bond Resolution, this Bond, or any unredeemed portion hereof, may, at the request of the registered owner or the assignee or assignees hereof, be converted into and exchanged for a like aggregate principal amount of fully registered bonds, without interest coupons, payable to the appropriate registered owner, assignee, or assignees, as the case may be, having the same maturity date, and bearing interest at the same rate, in any denomination or denominations in any integral multiple of $5,000 as requested in writing by the appropriate registered owner, assignee, or assignees, as the case may be, upon surrender of this Bond to the Paying Agent/Registrar for cancellation, all in accordance with the form and procedures set forth in the Bond Resolution. The Issuer shall pay the Paying Agent/Registrar's standard or customary fees and charges for transferring, converting, and exchanging any Bond or any portion thereof, but the one requesting such transfer, conversion, and exchange shall pay any taxes or governmental charges required to be paid with respect thereto as a condition precedent to the exercise of such privilege of conversion and exchange. The Paying Agent/Registrar shall not be required to make any such conversion and exchange (i) during the period commencing with the close of business on any Record Date and ending with the opening of business on the next following principal or interest payment date, or, (ii) with respect to any Bond or portion thereof called for redemption prior to maturity, within 45 days prior to its redemption date.

IN THE EVENT any Paying Agent/Registrar for the Bonds is changed by the Issuer, resigns, or otherwise ceases to act as such, the Issuer has covenanted in the Bond Resolution that it promptly will appoint a competent and legally qualified substitute therefor, and promptly will cause written notice thereof to be mailed to the registered owners of the Bonds.

IT IS HEREBY certified, recited, and covenanted that this Bond has been duly and validly authorized, issued, and delivered; that all acts, conditions, and things required or proper to be performed, exist, and be done precedent to or in the authorization, issuance, and delivery of this Bond have been performed, existed, and been done in accordance with law; that this Bond and the interest thereon, are special obligations of the Issuer which, together with other outstanding bonds of the Issuer, are secured by and payable equally and ratably on a parity from a first lien on and

pledge of the "Pledged Revenues," as defined in the Bond Resolution, which include the "Net Revenues of the District's Water System," as defined in the Bond Resolution, which specifically include certain amounts to be received by the Issuer (i) pursuant to the "Tarrant County Regional Water Supply Facilities Contract", dated August 29, 1979, among the Issuer and the Cities of Fort Worth and Mansfield, Texas, the "Tarrant County Regional Water Supply Facilities Supplemental Contract For Trinity River Authority of Texas," dated as of March 12, 1979 between the Issuer and Trinity River Authority of Texas, and the "Tarrant County Regional Water Supply Facilities Amendatory Contract," dated September 1, 1982, among the Issuer, the Cities of Fort Worth, Arlington, and Mansfield, Texas, and Trinity River Authority of Texas, which last named amendatory contract consolidates the previous contracts between such parties with respect to the Issuer's Water System into one instrument and sets forth the entire agreement between such parties with respect to the Issuer's Water System, and (ii) pursuant to contracts with other water customers of the Issuer.

THE ISSUER has reserved the right, subject to the restrictions stated in the Bond Resolution, to issue Additional Bonds payable from and secured by a first lien on and pledge of the "Pledged Revenues" on a parity with this Bond.

THE ISSUER also has reserved the right to amend the Bond Resolution, with the approval of the owners of 51% of the outstanding bonds secured by a first lien on the Pledged Revenues, subject to the restrictions stated in the Bond Resolution.

THE REGISTERED OWNER hereof shall never have the right to demand payment of this Bond or the interest hereon out of any funds raised or to be raised by taxation or from any source whatsoever other than as specified in the Bond Resolution.

BY BECOMING the registered owner of this Bond, the registered owner thereby acknowledges all of the terms and provisions of the Bond Resolution, agrees to be bound by such terms and provisions, acknowledges that the Bond Resolution is duly recorded and available for inspection in the official minutes and records of the governing body of the Issuer, and agrees that the terms and provisions of this Bond and the Bond Resolution constitute a contract between each registered owner hereof and the Issuer.

IN WITNESS WHEREOF, the Issuer has caused this Bond to be signed with the facsimile signature of the President of the Board of Directors of the Issuer and countersigned with the facsimile signature of the Secretary of the Board of Directors of the Issuer, and has caused the official seal of the Issuer to be duly impressed, or placed in facsimile, on this Bond.

xxxxxxx	xxxxxxx
Secretary, Board of Directors	President, Board of Directors

(DISTRICT SEAL)

FORM OF PAYING AGENT/REGISTRAR'S AUTHENTICATION CERTIFICATE

PAYING AGENT/REGISTRAR'S AUTHENTICATION CERTIFICATE

(To be executed if this Bond is not accompanied by an executed Registration Certificate of the Comptroller of Public Accounts of the State of Texas)

It is hereby certified that this Bond has been issued under the provisions of the Bond Resolution described in the text of this Bond; and that this Bond has been issued in conversion or replacement of, or in exchange for, a bond, bonds, or a portion of a bond or bonds of a Series which originally was approved by the Attorney General of the State of Texas and registered by the Comptroller of Public Accounts of the State of Texas.

Dated

BOFK, NA d/b/a BANK OF TEXAS,
Dallas, Texas

By _____
Authorized Representative

FORM OF ASSIGNMENT

ASSIGNMENT

FOR VALUE RECEIVED, the undersigned sells, assigns and transfers unto

Please Insert Social Security or
Other Identifying Number of Assignee
/_____/

_____
(Name and Address of Assignee)
the within Bond and does hereby irrevocably constitute and appoint _____ to transfer said Bond on the books kept for registration thereof with full power of substitution in the premises.

Date: _____

_____

Signature Guaranteed: _____

NOTICE: The signature to this assignment must correspond with the name as it appears upon the face of the within Bond in every particular, without alteration or enlargement or any change whatever; and

NOTICE: Signature(s) must be guaranteed by an eligible guarantor institution participating in a Securities Transfer Association recognized signature guarantee program.

Section 8. ADDITIONAL DEFINITIONS. In addition to the definitions heretofore provided for, the following terms as used in this Resolution shall have the meanings set forth below, unless the text hereof specifically indicates otherwise:

The term "Additional Bonds" shall mean the additional parity revenue bonds permitted to be authorized in the future on a parity with the Bonds, as hereinafter provided in Sections 21 and 22 hereof.

The term "Board" shall mean the Board of Directors of the District, being the governing body of the District, and it is further resolved that the declarations and covenants of the District contained in this Resolution are made by, and for and on behalf of the Board and the District, and are binding upon the Board and the District for all purposes.

The terms "Bond Resolution" and "Resolution" shall mean this resolution authorizing the Series 2015A Bonds; and it is hereby resolved and provided that Sections 8 through 24 of this Bond Resolution are applicable to all of the Bonds, as hereinafter defined, and substantially restate and are supplemental to and cumulative of Sections 8 through 24 of each of the Series 2008A Bond Resolution, Series 2008B Bond Resolution, Series 2009 Bond Resolution, Series 2010 Bond Resolution, Series 2010A Bond Resolution, Series 2010B Bond Resolution, Series 2012 Bond Resolution, Series 2012A Bond Resolution, the Series 2014 Bond Resolution, and the Series 2015 Bond Reoslution with the appropriate changes and additions which are required with respect to the issuance of the Series 2015A Bonds.

The term "Bonds" shall mean collectively (i) the unpaid and unrefunded Series 2008A Bonds, Series 2008B Bonds, Series 2009 Bonds, Series 2010 Bonds, Series 2010A Bonds, Series 2010B Bonds, Series 2012 Bonds, Series 2012A Bonds, the Series 2014 Bonds, and the Series 2015 Bonds to be outstanding at any time after the delivery of the Initial Bond, and (ii) the Series 2015A Bonds.

The term "Code" shall mean the Internal Revenue Code of 1986, as amended.

The term "Contracts" shall mean collectively: (a) the "Tarrant County Regional Water Supply Facilities Contract", dated as of August 29, 1979, among the District and the Cities of Fort Worth and Mansfield, Texas, the "Tarrant County Regional Water Supply Facilities Supplemental Contract For Trinity River Authority of Texas", dated as of March 12, 1979, between the District and Trinity River Authority of Texas, and the "Tarrant County Regional Water Supply Facilities Amendatory Contract", dated September 1, 1982, among the District, the Cities of Fort Worth, Arlington, and Mansfield, Texas, and Trinity River Authority of Texas, which last named amendatory contract consolidates the previous contracts between such parties with respect to the System into one instrument and sets forth the entire agreement between such parties with respect to the System; and (b) all water supply contracts heretofore or hereafter executed between the District and other cities and customers in connection with the District's Water System.

The terms "District" and "Issuer" shall mean Tarrant Regional Water District, a Water Control and Improvement District.

The term "District's Water System," "Issuer's Water System," or "System" shall mean all of the District's existing water storage, treatment, transportation, distribution, and supply facilities, including all dams, reservoirs, and other properties, wherever located, (a) which are currently being used for water supply purposes and, to the extent financed with the proceeds from the sale of the Bonds or Additional Bonds or moneys from the Contingency Fund (hereinafter created), all facilities acquired or constructed in the future, and all improvements to any of the foregoing, and (b) all other facilities which in the future are deliberately and specifically, at the option of the Board, made a part of the System by resolution of the Board, but such term does not include any oil, gas, and other mineral properties owned by the District or property disposed of from time to time in accordance with the provisions of Section 23(g) hereof, provided that any property acquired in substitution therefor shall be included in the System, along with all repairs to and other replacements of the System. In particular such term includes and shall include (i) all of the District's existing Cedar Creek Project, a dam and reservoir on Cedar Creek in Henderson and Kaufman Counties, Texas, and Eagle Mountain Dam and Reservoir and Bridgeport Dam and Reservoir, which are water supply facilities of the District on the West Fork of the Trinity River, Richland-Chambers Reservoir in Navarro and Freestone Counties, Texas, and all transportation, storage, and other facilities related to all of the foregoing and (ii) the Projects which were, or are to be, financed or refinanced with the proceeds from the sale of bonds originally authorized by the Series 1983 Bond Resolution, the Series 1986 Bond Resolution, Series 1999 Bond Resolution, the Series 2002 Bond Resolution, the Series 2006 Bond Resolution, the Series 2008A Bond Resolution, the Series 2008B Bond Resolution, the Series 2009 Bond Resolution, the Series 2010 Bond Resolution, the Series 2010A Bond Resolution, the Series 2010B Bond Resolution, the Series 2012 Bond Resolution, the Series 2012A Bond Resolution, the Series 2014 Bond Resolution, the Series 2015 Bond Resolution, and this Bond Resolution and made a part of the System. Unless deliberately added to the System by the Board, at its option, in the manner prescribed above, said term does not include any District flood control facilities or facilities which provide waste treatment or other wastewater services of any kind. Said term does not include any facilities acquired or constructed by the District with the proceeds from the issuance of "Special Facilities Bonds," which are hereby defined as being revenue obligations of the District, which are not issued as Additional Bonds, and which are payable from any source, contract, or revenues whatsoever other than the Pledged Revenues; and Special Facilities Bonds may be issued for any lawful purpose and made payable from any source, contract, or revenues whatsoever other than the Pledged Revenues.

The term "Gross Revenues of the System" shall mean all of the revenues, income, rentals, rates, fees, and charges of every nature derived by the Board or the District from the operation and/or ownership of the System (except as hereinafter provided), including specifically all payments and amounts received by the Board or the District from Contracts, and any interest income from the investment of money in any Funds created or maintained pursuant to any resolution authorizing the issuance of Bonds or Additional Bonds, excepting only any Construction Fund created pursuant to any resolution authorizing any Bonds or Additional Bonds. There is excepted from such term, and such term does not include (i) revenues derived by the District from the production of oil, gas, and other minerals owned by the District, or the revenues derived from the granting, sale, or lease of the right to explore for and produce same, or (ii) the royalties, rentals, license fees, and other income (other than from water sales) derived by the District from (a) lands and assets owned by the District as flood control facilities or (b) property of the District at Eagle Mountain Dam and Reservoir and Bridgeport Dam and Reservoir on the West Fork of the Trinity River.

The term "Operating and Maintenance Expenses of the System" or "Current Expenses" shall mean all reasonable and necessary current costs of operation and maintenance of the System including, but not limited to, repairs and replacements, operating personnel, utilities, supervision, engineering, accounting, auditing, legal services, insurance premiums, paying agents fees, and any other supplies and services, administration of the System, and equipment necessary for proper operation and maintenance of the System, as well as payments made for the use or operation of any property, and payments made by the District in satisfaction of judgments or other liabilities resulting from claims not covered by the District's insurance. Neither depreciation nor any other expense which does not represent a cash expenditure shall be considered an item of Operation and Maintenance Expense.

The terms "Net Revenues of the District's Water System", "Net Revenues of the System", and "Net Revenues" shall mean the Gross Revenues of the System less the Operation and Maintenance Expenses of the System.

The term "Pledged Revenues" shall mean: (a) the Net Revenues of the System and (b) any additional revenues, income, receipts, grants, donations, or other resources, received or to be received from any public or private source, whether pursuant to an agreement or otherwise, which in the future may, at the option of the District, be pledged to the payment of the Bonds or the Additional Bonds.

The term "Series 1983 Bond Resolution" shall mean the resolution adopted by the Board of Directors of the District on May 18, 1983, authorizing the Tarrant County Water Control and Improvement District Number One Water Revenue Bonds, Series 1983.

The term "Series 1986 Bond Resolution" shall mean the resolution adopted by the Board of Directors of the District on July 15, 1986, authorizing the Tarrant County Water Control and Improvement District Number One Water Revenue Bonds, Series 1986.

The term "Series 1999 Bond Resolution" shall mean the Resolution adopted by the Board of Directors of the District on May 18, 1999, authorizing Tarrant Regional Water District, a Water Control and Improvement District, Water Revenue Refunding and Improvement Bonds, Series 1999.

The term "Series 2002 Bond Resolution" shall mean the Resolution adopted by the Board of Directors of the District on December 17, 2002, authorizing Tarrant Regional Water District, a Water Control and Improvement District, Water Revenue Refunding and Improvement Bonds, Series 2002.

The term "Series 2006 Bond Resolution" shall mean the Resolution adopted by the Board of Directors of the District on March 21, 2006, authorizing Tarrant Regional Water District, a Water Control and Improvement District, Water Revenue Bonds, Series 2006.

The term "Series 2008A Bond Resolution" shall mean the Resolution adopted by the Board of Directors of the District on June 17, 2008, authorizing Tarrant Regional Water District, a Water Control and Improvement District, Water Revenue Bonds, Series 2008A.

The term "Series 2008A Bonds" shall mean all unpaid and unrefunded Series 2008A Bonds authorized by the Series 2008A Bond Resolution.

The term "Series 2008B Bond Resolution" shall mean the Resolution adopted by the Board of Directors of the District on June 17, 2008, authorizing Tarrant Regional Water District, a Water Control and Improvement District, Water Revenue Bonds, Series 2008B.

The term "Series 2008B Bonds" shall mean all unpaid and unrefunded Series 2008B Bonds authorized by the Series 2008B Bond Resolution.

The term "Series 2009 Bond Resolution" shall mean the Resolution adopted by the Board of Directors of the District on January 20, 2009, authorizing Tarrant Regional Water District, a Water Control and Improvement District, Water Revenue Refunding and Improvement Bonds, Series 2009.

The term "Series 2009 Bonds" shall mean all unpaid and unrefunded Series 2009 Bonds authorized by the Series 2009 Bond Resolution.

The term "Series 2010 Bond Resolution" shall mean the Resolution adopted by the Board of Directors of the District on January 19, 2010, authorizing Tarrant Regional Water District, a Water Control and Improvement District, Water Revenue Bonds, Series 2010.

The term "Series 2010 Bonds" shall mean all unpaid and unrefunded Series 2010 Bonds authorized by the Series 2010 Bond Resolution.

The term "Series 2010A Bond Resolution" shall mean the Resolution adopted by the Board of Directors of the District on May 18, 2010, authorizing Tarrant Regional Water District, a Water Control and Improvement District, Water Revenue Bonds, Series 2010A.

The term "Series 2010A Bonds" shall mean all unpaid and unrefunded Series 2010A Bonds authorized by the Series 2010A Bond Resolution.

The term "Series 2010B Bond Resolution" shall mean the Resolution adopted by the Board of Directors of the District on May 18, 2010, authorizing Tarrant Regional Water District, a Water Control and Improvement District, Water Revenue Bonds, Series 2010B.

The term "Series 2010B Bonds" shall mean all unpaid and unrefunded Series 2010B Bonds authorized by the Series 2010B Bond Resolution.

The term "Series 2012 Bond Resolution" shall mean the Resolution adopted by the Board of Directors of the District on January 17, 2012, authorizing Tarrant Regional Water District, a Water Control and Improvement District, Water Revenue Refunding and Improvement Bonds, Series 2012.

The term "Series 2012 Bonds" shall mean all unpaid and unrefunded Series 2012 Bonds authorized by the Series 2012 Bond Resolution.

The term "Series 2012A Bond Resolution" shall mean the Resolution adopted by the Board of Directors of the District on September 18, 2012, authorizing Tarrant Regional Water District, a Water Control and Improvement District, Water Revenue Refunding Bonds, Series 2012A.

The term "Series 2012A Bonds" shall mean all unpaid and unrefunded Series 2012A Bonds authorized by the Series 2012A Bond Resolution

The term "Series 2014 Bond Resolution" shall mean the Resolution adopted by the Board of Directors of the District on January 21, 2014, authorizing Tarrant Regional Water District, a Water Control and Improvement District, Water Revenue Bonds, Series 2014.

The term "Series 2014 Bonds" shall mean all unpaid and unrefunded Series 2014 Bonds authorized by the Series 2014 Bond Resolution

The term "Series 2015 Bond Resolution" shall mean the Resolution adopted by the Board of Directors of the District on January 20, 2015, authorizing Tarrant Regional Water District, a Water Control and Improvement District, Water Revenue Refunding Bonds, Series 2015.

The term "Series 2015 Bonds" shall mean all unpaid and unrefunded Series 2015 Bonds authorized by the Series 2015 Bond Resolution.

The term "Series 2015A Bonds" shall mean collectively the Initial Bond as described and defined in Sections 1, 2, and 3 of this Bond Resolution, and all substitute bonds exchanged therefor, as well as all other substitute bonds and replacement bonds issued pursuant to this Bond Resolution, all as provided for herein; and the Series 2015A Bonds are Additional Bonds issued to be payable from and secured by a first lien on and pledge of the Pledged Revenues equally and ratably on a parity with all of the other Bonds, Sections 21 and 22 of the Series 2008A Bond Resolution, the Series 2008B Bond Resolution, the Series 2009 Bond Resolution, the Series 2010 Bond Resolution, the Series 2010A Bond Resolution, the Series 2010B Bond Resolution, the Series 2012 Bond Resolution, the Series 2012A Bond Resolution, the Series 2014 Bond Resolution, and the Series 2015 Bond Resolution.

The term "TWDB" shall mean the Texas Water Development Board.

The terms "year" and "fiscal year" shall mean the District's fiscal year, which currently ends on September 30, but which subsequently may be any other 12 month period hereafter established by the District as a fiscal year for the purposes of the System and any resolution authorizing the Bonds or any Additional Bonds.

Section 9. PLEDGE. (a) That the Bonds, as defined above, and any Additional Bonds, and the interest thereon, are and shall be secured equally and ratably on a parity by and payable from a first lien on and pledge of the Pledged Revenues; and the Series 2015A Bonds are Additional Bonds payable from and secured by a first lien on and pledge of the Pledged Revenues, as permitted by Sections 21 and 22 of the Series 2008A Bond Resolution, Series 2008B Bond Resolution, Series 2009 Bond Resolution, Series 2010 Bond Resolution, Series 2010A Bond Resolution, Series 2010B

Bond Resolution, the Series 2012 Bond Resolution, the Series 2012A Bond Resolution, the Series 2014 Bond Resolution, and the Series 2015 Bond Resolution.

(b) That Chapter 1208, Government Code, applies to the issuance of the Bonds and the pledge of the revenues granted by the Issuer under this Section, and is therefore valid, effective, and perfected. Should Texas law be amended at any time while the Bonds are outstanding and unpaid, the result of such amendment being that the pledge of the revenues granted by the Issuer under this Section is to be subject to the filing requirements of Chapter 9, Business & Commerce Code, in order to preserve to the registered owners of the Bonds a security interest in said pledge, the Issuer agrees to take such measures as it determines are reasonable and necessary under Texas law to comply with the applicable provisions of Chapter 9, Business & Commerce Code and enable a filing of a security interest in said pledge to occur.

Section 10. REVENUE FUND. That there has been created and established, and there shall be maintained on the books of the District, and accounted for separate and apart from all other funds of the District, a special fund to be entitled the "Tarrant Regional Water District Water Revenue Bonds Revenue Fund" (hereinafter called the "Revenue Fund"). All Gross Revenues of the System (except investment interest and income from the other Funds hereinafter described and maintained) shall be credited to the Revenue Fund immediately upon receipt. All Operation and Maintenance Expenses of the System shall be paid from such Gross Revenues credited to the Revenue Fund, as a first charge against same.

Section 11. INTEREST AND REDEMPTION FUND. That for the sole purpose of paying the principal of and interest on all Bonds and any Additional Bonds, as the same come due, either upon redemption or at maturity, there has been created and established, and there shall be maintained, at an official depository bank of the District, a separate fund to be entitled the "Tarrant Regional Water District Revenue Bonds Interest and Redemption Fund" (hereinafter called the "Interest and Redemption Fund").

Section 12. THE CONTINGENCY AND IMPROVEMENT FUND AND THE RESERVE FUND. (a) That there has been created and established and there shall be maintained, at an official depository bank of the District, a separate fund to be entitled the "Tarrant Regional Water District Water Revenue Bonds Contingency and Improvement Fund" (hereinafter called the "Contingency Fund"). The Contingency Fund shall be used solely for the purpose of paying the costs of improvements, enlargements, extensions, additions, or other capital expenditures relating to the System, and unexpected or extraordinary replacements of the System, for which System funds are not otherwise available, or for paying unexpected or extraordinary Operation and Maintenance Expenses of the System for which System Funds are not otherwise available, or for paying principal of and interest on any Bonds or Additional Bonds, when and to the extent the amount in the Interest and Redemption Fund is insufficient for such purpose.

(b) That there has been created and established and there shall be maintained at an official depository bank of the District, a separate fund to be entitled the "Tarrant Regional Water District Water Revenue Bonds Reserve Fund" (hereinafter called the "Reserve Fund"), solely for the further security and benefit of the Bonds and any Additional Bonds. The Reserve Fund shall be used solely for the purpose of (i) finally retiring the last of the Bonds and any Additional Bonds, and (ii)

paying principal of and interest on the Bonds or any Additional Bonds when and to the extent the amounts in the Interest and Redemption Fund and Contingency Fund are insufficient for such purpose. Out of proceeds of the Bonds, there shall be deposited to the Reserve Fund an amount of money, if any, sufficient to cause the Reserve Fund to contain the Required Amount (hereinafter defined). When and so long as the money and investments in the Reserve Fund are not less in market value than a "Required Amount" equal to the principal and interest requirements of the Bonds during the fiscal year in which such requirements are scheduled to be the greatest, no deposits shall be made to the credit of the Reserve Fund; but when and if the Reserve Fund at any time thereafter contains less than said "Required Amount" in market value, then, subject and subordinate to making the required deposits to the credit of the Interest and Redemption Fund, the District shall transfer from Pledged Revenues and deposit to the credit of the Reserve Fund, semiannually on or before the 25th days of each February and each August of each year, a sum equal to 1/10th of the "Required Amount" until the Reserve Fund is restored to said "Required Amount." So long as the Reserve Fund contains said "Required Amount" in market value, all amounts in excess of said "Required Amount," if any, shall, at least annually, on or before the 25th day of February of each year, be deposited to the credit of the Interest and Redemption Fund.

Section 13. DEPOSITS OF PLEDGED REVENUES; INVESTMENTS. (a) That the Pledged Revenues shall be deposited into the Interest and Redemption Fund, the Reserve Fund, and the Contingency Fund, when and as required by this Bond Resolution, Sections 8 through 24 of which are cumulative of and supplemental to Sections 8 through 24 of the Series 2008A Bond Resolution, the Series 2008B Bond Resolution, the Series 2009 Bond Resolution, the Series 2010 Bond Resolution, the Series 2010A Bond Resolution, the Series 2010B Bond Resolution, the Series 2012 Bond Resolution, the Series 2012A Bond Resolution, the Series 2014 Bond Resolution, and the Series 2015 Bond Resolution, and Sections 8 through 24 of this Bond Resolution shall be applicable to all of the Bonds.

(b) That money in any Fund maintained pursuant to this Bond Resolution may, at the option of the District, be placed in time deposits or certificates of deposit secured by obligations of the type hereinafter described, or be invested in direct obligations of the United States of America, obligations guaranteed or insured by the United States of America, which, in the opinion of the Attorney General of the United States, are backed by its full faith and credit or represent its general obligations, or invested in indirect obligations of the United States of America, including, but not limited to, evidences of indebtedness issued, insured, or guaranteed by such governmental agencies as the Federal Land Banks, Federal Intermediate Credit Banks, Banks for Cooperatives, Federal Home Loan Banks, Government National Mortgage Association, United States Postal Service, Farmers Home Administration, Federal Home Loan Mortgage Association, Small Business Administration, Federal Housing Association, or Participation Certificates in the Federal Assets Financing Trust; provided that all such deposits and investments shall be made in such manner that the money required to be expended from any Fund will be available at the proper time or times. Such investments shall be valued by the District in terms of current market value as of the 20th day of February of each year. All interest and income derived from such deposits and investments immediately shall be credited to, and any losses debited to, the Fund from which the deposit or investment was made, and surpluses in any Fund shall be disposed of as herein provided. Such investments shall be sold promptly when necessary to prevent any default in connection with the Bonds or Additional Bonds.

Section 14. FUNDS SECURED. That money in all Funds described in this Bond Resolution shall be secured in the manner prescribed by law for securing funds of the District.

Section 15. DEBT SERVICE REQUIREMENTS. (a) That promptly after the delivery of the Initial Bond the District shall cause to be deposited to the credit of the Interest and Redemption Fund all accrued interest, if any, received from the sale and delivery of the Initial Bond, and any such deposit shall be used to pay part of the interest coming due on the Series 2015A Bonds.

(b) That the District shall transfer from the Pledged Revenues and deposit to the credit of the Interest and Redemption Fund the amounts, at the times, as follows:

(1) such amounts, deposited semiannually on or before the 25th day of each February and each August of each year, as will be sufficient, together with other amounts, if any, then on hand in the Interest and Redemption Fund and available for such purpose, to pay the interest scheduled to accrue and come due on all Bonds on the next succeeding interest payment date; and

(2) such amounts, deposited annually, on or before the 25th day of each February, as will be sufficient, together with other amounts, if any, then on hand in the Interest and Redemption Fund and available for such purpose, to pay all principal scheduled to mature and come due on all Bonds on the next succeeding March 1, and to pay all principal of all Bonds, if any, scheduled to be redeemed prior to maturity on the next succeeding March 1 in accordance with the mandatory redemption provisions and schedules set forth in any applicable Bond Resolution.

Section 16. CONTINGENCY REQUIREMENTS. That there is now on deposit to the credit of the Contingency Fund an amount equal to at least $1,100,000. No additional deposits are required to be made to the credit of the Contingency Fund unless and until such amount therein is reduced or depleted. If and when such amount in the Contingency Fund is reduced or depleted then, subject and subordinate to making the required deposits to the credit of the Interest and Redemption Fund and the Reserve Fund, such reduction or depletion shall be restored from amounts which shall be provided for such purpose in the District's Annual Budget for the next ensuing fiscal year or years; provided that the District is not required to budget more than $100,000 for such purpose during any one fiscal year; but the District shall have the right to budget additional amounts for such purpose if it is deemed necessary or advisable by the Board. So long as the Contingency Fund contains money and investments not less than the amount of $1,100,000 in market value, any surplus in the Contingency Fund over said amount shall, semiannually on or before February 15 and August 15 of each year, be withdrawn, deposited to the credit of the Revenue Fund, commingled with other revenues from the operation of the System, and used for any lawful purpose for which Gross Revenues of the System may be used.

Section 17. DEFICIENCIES; EXCESS PLEDGED REVENUES. (a) That if on any occasion there shall not be sufficient Pledged Revenues to make the required deposits into the Interest and Redemption Fund, the Reserve Fund, and the Contingency Fund, then such deficiency shall be made up as soon as possible from the next available Pledged Revenues, or from any other sources available for such purpose.

(b) That, subject to making the required deposits to the credit of the Interest and Redemption Fund, the Reserve Fund, and the Contingency Fund, when and as required by this Bond Resolution, or any resolution authorizing the issuance of Additional Bonds, the excess Pledged Revenues may be used for any lawful purpose.

Section 18. BONDS AND ADDITIONAL BONDS NOT PAYABLE FROM TAXES. It is specifically provided that the District is not authorized to, and shall not, levy, collect, or use any tax of any nature to pay the principal of or interest on any of the Bonds or Additional Bonds.

Section 19. PAYMENT OF BONDS AND ADDITIONAL BONDS. Semiannually on or before each March 1 and September 1 while any of the Bonds or Additional Bonds are outstanding and unpaid, the District shall make available to the paying agents therefor, ratably and on a parity out of the Interest and Redemption Fund, and/or the Contingency Fund, or, from the Reserve Fund, money sufficient to pay such interest on and such principal of the Bonds or Additional Bonds as will accrue or mature, or which is scheduled to be redeemed prior to maturity, on each such March 1 and September 1, respectively. The paying agents shall destroy all paid Bonds or Additional Bonds, and the coupons, if any, appertaining thereto, and furnish the District with an appropriate certificate of cancellation or destruction.

Section 20. DEFEASANCE OF BONDS. (a) Any Bond and the interest thereon shall be deemed to be paid, retired, and no longer outstanding (a "Defeased Bond") within the meaning of this Resolution, except to the extent provided in subsection (d) of this Section, when payment of the principal of such Bond, plus interest thereon to the due date (whether such due date be by reason of maturity, or otherwise) either (i) shall have been made or caused to be made in accordance with the terms thereof or (ii) shall have been provided for on or before such due date by irrevocably depositing with or making available to the Paying Agent/Registrar in accordance with an escrow agreement or other instrument (the "Future Escrow Agreement") for such payment (1) lawful money of the United States of America sufficient to make such payment or (2) Defeasance Securities that mature as to principal and interest in such amounts and at such times as will insure the availability, without reinvestment, of sufficient money to provide for such payment, and when proper arrangements have been made by the Issuer with the Paying Agent/Registrar for the payment of its services until all Defeased Bonds shall have become due and payable. At such time as a Bond shall be deemed to be a Defeased Bond hereunder, as aforesaid, such Bond and the interest thereon shall no longer be secured by, payable from, or entitled to the benefits of, the revenues herein pledged as provided in this Resolution, and such principal and interest shall be payable solely from such money or Defeasance Securities. Notwithstanding any other provision of this Resolution to the contrary, it is hereby provided that any determination not to redeem Defeased Bonds that is made in conjunction with the payment arrangements specified in subsection 20(a)(i) or (ii) shall not be irrevocable, provided that: (1) in the proceedings providing for such payment arrangements, the Issuer expressly reserves the right to call the Defeased Bonds for redemption; (2) the Issuer gives notice of the reservation of that right to the owners of the Defeased Bonds immediately following the making of the payment arrangements, and (3) the Issuer directs that notice of the reservation be included in any redemption notices that it authorizes.

(b) Any moneys so deposited with the Paying Agent/Registrar may at the written direction of the Issuer also be invested in Defeasance Securities, maturing in the amounts and times as hereinbefore set forth, and all income from such Defeasance Securities received by the Paying Agent/Registrar that is not required for the payment of the Bonds and interest thereon, with respect to which such money has been so deposited, shall be turned over to the Issuer, or deposited as directed in writing by the Issuer. Any Future Escrow Agreement pursuant to which the money and/or Defeasance Securities are held for the payment of Defeased Bonds may contain provisions permitting the investment or reinvestment of such moneys in Defeasance Securities or the substitution of other Defeasance Securities upon the satisfaction of the requirements specified in subsection 20(a)(i) or (ii). All income from such Defeasance Securities received by the Paying Agent/Registrar which is not required for the payment of the Defeased Bonds, with respect to which such money has been so deposited, shall be remitted to the Issuer or deposited as directed in writing by the Issuer.

(c) The term "Defeasance Securities" means (i) direct, noncallable obligations of the United States of America, including obligations that are unconditionally guaranteed by the United States of America, (ii) noncallable obligations of an agency or instrumentality of the United States of America, including obligations that are unconditionally guaranteed or insured by the agency or instrumentality and that, on the date of the purchase thereof are rated as to investment quality by a nationally recognized investment rating firm not less than AAA or its equivalent, and (iii) noncallable obligations of a state or an agency or a county, municipality, or other political subdivision of a state that have been refunded and that, on the date the governing body of the Issuer adopts or approves the proceedings authorizing the financial arrangements are rated as to investment quality by a nationally recognized investment rating firm not less than AAA or its equivalent.

(d) Until all Defeased Bonds shall have become due and payable, the Paying Agent/Registrar shall perform the services of Paying Agent/Registrar for such Defeased Bonds the same as if they had not been defeased, and the Issuer shall make proper arrangements to provide and pay for such services as required by this Resolution.

(e) In the event that the Issuer elects to defease less than all of the principal amount of Bonds of a maturity, the Paying Agent/Registrar shall select, or cause to be selected, such amount of Bonds by such random method as it deems fair and appropriate.

Section 21. ADDITIONAL BONDS. (a) That the District shall have the right and power at any time and from time to time, and in one or more Series or issues, to authorize, issue, and deliver additional bonds (herein called "Additional Bonds"), which may be payable from and secured by a first lien on and pledge of the Pledged Revenues. No Additional Bonds shall be payable from or secured by ad valorem or other taxes.

(b) Additional Bonds, if and when authorized, issued, and delivered in accordance with the provisions hereof, shall be payable from the Interest and Redemption Fund, and shall be payable from and secured by a first lien on and pledge of the Pledged Revenues, equally and ratably on a parity with the Bonds and all other outstanding Additional Bonds.

(c) That the principal of all Additional Bonds must be scheduled to be paid or mature on March 1 of the years in which such principal is scheduled to be paid or mature; and all interest thereon must be payable on March 1 and September 1.

Section 22. FURTHER REQUIREMENTS FOR ADDITIONAL BONDS. (a) That Additional Bonds shall be issued only in accordance with the provisions hereof, and then applicable laws, and may be issued in any amounts, for any lawful purpose relating to the System, including the refunding of any Bonds or Additional Bonds. No installment, Series, or issue of Additional Bonds shall be issued or delivered unless the President and the Secretary of the Board sign a written certificate to the effect (i) that the District is not in default as to any covenant, condition, or obligation in connection with all outstanding Bonds and Additional Bonds, and the resolutions authorizing the same, (ii) that the Interest and Redemption Fund and the Reserve Fund contain the amount then required to be therein, and (iii) that either (1) the Pledged Revenues in each fiscal year, commencing (A) with the third complete fiscal year following the execution of such certificate or report, or (B) with the fiscal year following the estimated completion date of any project for which the then proposed Additional Bonds are being issued (whichever of (A) or (B) is later) are estimated, based on a report of an independent engineer or firm of engineers, to be at least equal to 1.25 times the average annual principal and interest requirements of all Bonds and Additional Bonds to be outstanding after delivery of the then proposed Additional Bonds, or (2) based upon an opinion of legal counsel to the District, there are Contracts then in effect pursuant to which parties to such Contracts are obligated to make minimum payments to the District on a "take or pay" basis at such times and in such amounts as shall be necessary to provide to the District Pledged Revenues sufficient to pay when due all principal of and interest on all Bonds and Additional Bonds.

(b) That each resolution authorizing the issuance of Additional Bonds shall confirm the Reserve Fund as additional security for all such Additional Bonds, and the Reserve Fund shall be increased to the extent required to cause the Reserve Fund to be maintained in an amount not less than the principal and interest requirements, during the fiscal year in which such requirements are scheduled to be the greatest, of all Bonds and Additional Bonds to be outstanding after the issuance of such then proposed Additional Bonds (or any greater amount as may, at the option of the District, be provided for in any resolution authorizing the issuance of any Additional Bonds), and shall make provision for funding such Reserve Fund from Pledged Revenues, or, at the option of the District, from bond proceeds or other available sources. Such Reserve Fund may be funded in whole or in part initially, or may be funded in whole or in part from Pledged Revenues by approximately equal periodic payments, not less than annual, and within not more than five years from the date of such then proposed Additional Bonds.

(c) That all calculations of principal and interest requirements of any bonds made in connection with the issuance of any then proposed Additional Bonds shall be made as of the date of such Additional Bonds; and also in making calculations for such purpose, or for any other purpose under any resolution authorizing any Bonds or Additional Bonds, the principal amounts of any Bonds or Additional Bonds which must be redeemed prior to maturity pursuant to any applicable mandatory redemption requirements shall be deemed to be maturing amounts of principal.

Section 23. GENERAL COVENANTS, REPRESENTATIONS, AND WARRANTIES. That the District further covenants, represents, warrants, and agrees that:

(a) PERFORMANCE. It will faithfully perform at all times any and all covenants, undertakings, stipulations, and provisions contained in each resolution authorizing the issuance of the Bonds and any Additional Bonds, and in each and every Bond and Additional Bond; that it will promptly pay or cause to be paid the principal of and interest on every Bond and Additional Bond, on the dates and in the places and manner prescribed in such resolutions and Bonds or Additional Bonds, and that it will, at the times and in the manner prescribed, deposit or cause to be deposited the amounts required to be deposited into the Interest and Redemption Fund; and any holder of the Bonds or Additional Bonds may require the District, its Board, and its officials and employees, to carry out, respect, or enforce the covenants and obligations of each resolution authorizing the issuance of the Bonds and any Additional Bonds, by all legal and equitable means, including specifically, but without limitation, the use and filing of mandamus proceedings, in any court of competent jurisdiction, against the District, its Board, and its officials and employees.

(b) DISTRICT'S LEGAL AUTHORITY. It is a duly created and existing conservation and reclamation district of the State of Texas pursuant to Article 16, Section 59, of the Texas Constitution, and the laws of the State of Texas, and is duly authorized under the laws of the State of Texas to create and issue the Bonds; that all action on its part for the creation and issuance of the Bonds has been duly and effectively taken, and that the Bonds in the hands of the holders and owners thereof are and will be valid and enforceable obligations of the District in accordance with their terms.

(c) TITLE. It has acquired and constructed, and will operate and maintain the System, and has or will obtain lawful title to, or the lawful right to use and operate, the lands, buildings, and facilities constituting the System, that it warrants that it will defend the title to or lawful right to use and operate, all of the aforesaid lands, buildings, and facilities, and every part thereof, for the benefit of the holders and owners of the Bonds and Additional Bonds against the claims and demands of all persons whomsoever, and is lawfully qualified to pledge the Pledged Revenues to the payment of the Bonds and Additional Bonds in the manner prescribed herein, and has lawfully exercised such rights.

(d) LIENS. It will from time to time and before the same become delinquent pay and discharge all taxes, assessments, and governmental charges, if any, which shall be lawfully imposed upon it, or the System, that it will pay all lawful claims for rents, royalties, labor, materials, and supplies which if unpaid might by law become a lien or charge thereon, the lien of which would be prior to or interfere with the liens hereof, so that the priority of the liens granted hereunder shall be fully preserved in the manner provided herein, and that it will not create or suffer to be created any mechanic's, laborer's, materialman's, or other lien or charge which might or could be prior to the liens hereof, or do or suffer any matter or thing whereby the liens hereof might or could be impaired; provided, however, that no such tax, assessment, or charge, and that no such claims which might be used as the basis of a mechanic's, laborer's, materialman's, or other lien or charge, shall be required to be paid so long as the validity of the same shall be contested in good faith by the District.

(e) OPERATION OF THE SYSTEM. While the Bonds or any Additional Bonds are outstanding and unpaid it will cause the System to be continuously and efficiently operated and maintained in good condition, repair, and working order, and at a reasonable cost.

(f) FURTHER ENCUMBRANCE. While the Bonds or any Additional Bonds are outstanding and unpaid, it will not additionally encumber the Pledged Revenues in any manner, except as permitted hereby in connection with Additional Bonds, unless said encumbrance is made junior and subordinate in all respects to the liens, pledges, covenants, and agreements of each resolution authorizing the issuance of the Bonds and any Additional Bonds; but the right of the District and the Board to issue revenue bonds for any lawful purpose payable from a subordinate lien on the Pledged Revenues is specifically recognized and retained. This Resolution does not and is not intended to affect, limit, or prohibit the issuance of bonds payable solely from ad valorem taxes.

(g) SALE OF PROPERTY. While the Bonds or any Additional Bonds, are outstanding and unpaid, it will maintain its current legal corporate status as a conservation and reclamation district, and it will not sell, convey, mortgage, or in any manner transfer title to, or lease or otherwise dispose of the entire System, or any significant or substantial part thereof; provided that whenever the District deems it necessary to dispose of any real or personal property, machinery, fixtures, or equipment, it may sell or otherwise dispose of such real or personal property, machinery, fixtures, or equipment when it has made arrangements to replace the same or provide substitutes therefor, unless it is determined by resolution of the Board that no such replacement or substitute is necessary; and all proceeds from the sale thereof shall be credited to the Revenue Fund. In all events counsel to the Issuer shall opine as to the validity of the Resolution, as supplemented and amended and counsel to the Contracting Parties shall opine on the validity of the obligation of the Contracting Parties under the Contract.

(h) INSURANCE. (1) It will carry or cause to be carried such insurance as usually would be carried by corporations or other business entities operating like properties and engaged in similar activities, with a responsible insurance company or companies; provided that no insurance shall be required to the extent that the Board determines, based on the advise of legal counsel, that no substantial liability can or will arise under a particular hazard. At any time while any contractor engaged in construction work shall be fully responsible therefor, the District shall not be required to carry insurance on the works being constructed, if the contractor is required to carry appropriate insurance. All such policies shall be open to the inspection of the owners or holders of the Bonds and Additional Bonds and their representatives at all reasonable times.

(2) Upon the happening of any loss or damage covered by insurance from one or more of said causes, the District shall make due proof of loss and shall do all things necessary or desirable to cause the insuring companies to make payment in full directly to the District. The proceeds of insurance covering such property, together with any other funds necessary and available for such purpose, shall be used forthwith by the District for repairing the property damaged or replacing the property destroyed; provided, however, that if said insurance proceeds and other funds are insufficient for such purpose, then said insurance proceeds pertaining to the System shall be used promptly as follows:

(a) for the redemption prior to maturity of the Bonds and Additional Bonds, if any, ratably in the proportion that the outstanding principal of each Series or issue of Bonds or Additional Bonds bears to the total outstanding principal of all Bonds and Additional Bonds; provided that if on any such occasion the principal of any such Series or issue is not

subject to redemption, it shall not be regarded as outstanding in making the foregoing computation; or

(b) if none of the outstanding Bonds or Additional Bonds is subject to redemption, then for the purchase on the open market and retirement of said Bonds and Additional Bonds, in the same proportion as prescribed in the foregoing clause (a), to the extent practicable; provided that the purchase price for any such Bond or Additional Bonds shall not exceed the redemption price of such Bond or Additional Bond on the first date upon which it becomes subject to redemption; or

(c) to the extent that the foregoing clauses (a) and (b) cannot be complied with at the time, the insurance proceeds, or the remainder thereof, shall be deposited in a special and separate trust fund, at an official depository of the District, to be designated the Insurance Account. The Insurance Account shall be held until such time as the foregoing clauses (a) and/or (b) can be complied with, or until other funds become available which, together with the Insurance Account, will be sufficient to make the repairs or replacements originally required, whichever of said events occurs first.

(3) The annual audit hereinafter required shall contain a list of all such insurance policies carried, together with a statement as to whether or not all insurance premiums upon such policies have been paid.

(i) RATE COVENANT. It will fix, establish, maintain, revise (if and when necessary), and collect such rates, charges, and fees for the sale of water from the System and for the use and availability of the System as are necessary to produce Gross Revenues of the System sufficient, together with any other Pledged Revenues and any taxes as may be levied by the District for such purpose, (1) to pay all Operation and Maintenance Expenses of the System, and (2) to produce Pledged Revenues adequate to provide for all payments and deposits required to be made into the Interest and Redemption Fund, the Reserve Fund, and the Contingency Fund, when and as required by the resolutions authorizing all Bonds and Additional Bonds.

(j) RECORDS. It will keep proper books of records and accounts in which full, true, and correct entries will be made of all dealings, activities, and transactions relating to the System, the Pledged Revenues, and all Funds created pursuant to each resolution authorizing the issuance of the Bonds and Additional Bonds; and all books, documents, and vouchers relating thereto shall at all reasonable times be made available for inspection upon request of any bondholder.

(k) AUDITS. Each year while any of the Bonds or Additional Bonds are outstanding, an audit will be made of its books and accounts relating to the System and the Pledged Revenues by an independent certified public accountant or an independent firm of certified public accountants. As soon as practicable after the close of each year, and when said audit has been completed and made available to the District, a copy of such audit for the preceding year shall be mailed to the Municipal Advisory Council of Texas and to any bondholders who shall so request in writing. Such annual audit reports shall be open to the inspection of the owners or holders of the Bonds and Additional Bonds and their agents and representatives at all reasonable times.

(1) GOVERNMENTAL AGENCIES. It will comply with all of the terms and conditions of any and all franchises, permits, and agreements applicable to the System and the Bonds or Additional Bonds entered into between the District and any governmental agency, and the District will take all action necessary to enforce said terms and conditions; and the District will obtain and keep in full force and effect all franchises, permits, and other requirements necessary with respect to the acquisition, construction, operation, and maintenance of the System.

(m) CONTRACTS. It will comply with the terms and conditions of the Contracts and will cause the other parties to the Contracts to comply with all of their obligations thereunder by all lawful means; and the Contracts will not be rescinded, modified, or amended in any way which would have a materially adverse effect on the operation of the System or the rights of the owners of the Bonds and Additional Bonds.

(n) ANNUAL BUDGET. On or before August 1 of each calendar year, it will prepare the preliminary Annual Budget of Operation and Maintenance Expenses of the System for the ensuing fiscal year, and such budget shall include a showing as to the proposed expenditures for such ensuing fiscal year, and shall show the estimated amount of Net Revenues of the System for such year. If the owners or holders of 25% in aggregate principal amount of the Bonds and Additional Bonds then outstanding shall so request on or before the 15th day of the aforesaid month, the Board shall hold a public hearing on or before the 15th day of the following month, at which any bondholder may appear in person or by agent or attorney and present any objections he may have to the final adoption of such budget. Notice of the time and place of such hearing shall be published twice, once in each of two successive weeks, in a newspaper of general circulation published in the District, with the date of the first publication to be at least fourteen days before the date fixed for the hearing; and copies of such notice shall be mailed at least ten days before the hearing to each bondholder who shall have filed his name and address with the Secretary of the Board for such purpose. The District further covenants that on or before October 1 of each calendar year it will finally adopt the Annual Budget of Operation and Maintenance Expenses of the System for such fiscal year (hereinafter sometimes called the "Annual Budget"). If for any reason the Board shall not have adopted the Annual Budget before the first day of any fiscal year, the budget for the preceding fiscal year shall be deemed to be in force until the adoption of the Annual Budget. The Operation and Maintenance Expenses of the System incurred in any fiscal year will not exceed the reasonable and necessary amount thereof. The District may, at any time deemed necessary by the Board, adopt an Amended or Supplemental Budget for the remainder of the then current fiscal year.

Section 24. AMENDMENT OF RESOLUTION. (a) The holders and registered owners of Bonds and Additional Bonds (hereinafter collectively called "holders") aggregating 51% in principal amount of the aggregate principal amount of then outstanding Bonds and Additional Bonds shall have the right from time to time to approve any amendment to any resolution authorizing the issuance of any Bonds or Additional Bonds, which may be deemed necessary or desirable by the District, provided, however, that nothing herein contained shall permit or be construed to permit the amendment of the terms and conditions in said resolutions or in the Bonds or Additional Bonds so as to:

(1) Make any change in the maturity of the outstanding Bonds or Additional Bonds;

(2) Reduce the rate of interest borne by any of the outstanding Bonds or Additional Bonds;

(3) Reduce the amount of the principal payable on the outstanding Bonds or Additional Bonds;

(4) Modify the terms of payment of principal of or interest on the outstanding Bonds or Additional Bonds, or impose any conditions with respect to such payment;

(5) Effect any change in the rights of the holders of the Bonds and Additional Bonds then outstanding, other than a change which similarly affects all such holders;

(6) Change the minimum percentage of the principal amount of Bonds and Additional Bonds necessary for consent to such amendment.

(b) If at any time the District shall desire to amend a resolution under this Section, the District shall cause notice of the proposed amendment to be published in a financial newspaper or journal published in The City of New York, New York, once during each calendar week for at least two successive calendar weeks. Such notice shall briefly set forth the nature of the proposed amendment and shall state that a copy thereof is on file at the principal office of each Paying Agent/Registrar for the Bonds and Additional Bonds, for inspection by all holders of Bonds and Additional Bonds. Such publication is not required, however, if notice in writing is given to each holder of Bonds and Additional Bonds.

(c) Whenever at any time not less than thirty days, and within one year, from the date of the first publication of said notice or other service of written notice the District shall receive an instrument or instruments executed by the holders of at least 51% in aggregate principal amount of all Bonds and Additional Bonds then outstanding, which instrument or instruments shall refer to the proposed amendment described in said notice and which specifically consent to and approve such amendment in substantially the form of the copy thereof on file as aforesaid, the District may adopt the amendatory resolution in substantially the same form.

(d) Upon the adoption of any amendatory resolution pursuant to the provisions of this Section, the resolution being amended shall be deemed to be amended in accordance with the amendatory resolution, and the respective rights, duties, and obligations of the District and all the holders of then outstanding Bonds and Additional Bonds and all future Additional Bonds shall thereafter be determined, exercised, and enforced hereunder, subject in all respects to such amendment.

(e) Any consent given by the holder of a Bond or Additional Bonds pursuant to the provisions of this Section shall be irrevocable for a period of six months from the date of the first publication of the notice provided for in this Section, and shall be conclusive and binding upon all future holders of the same Bond or Additional Bond during such period. Such consent may be revoked at any time after six months from the date of the first publication of such notice by the holder who gave such consent, or by a successor in title, by filing notice thereof with each Paying Agent/Registrar for the Bonds and Additional Bonds, and the District, but such revocation shall not be effective if the holders of 51% in aggregate principal amount of the then outstanding Bonds and

Additional Bonds as in this Section defined have, prior to the attempted revocation, consented to and approved the amendment.

(f) For the purpose of this Section, the fact of the holding of Bonds or Additional Bonds by any holder of Bonds or Additional Bonds which are not registered and which are payable to bearer, and the amount and numbers of such registered Bonds and Additional Bonds, and the date of their holding same, may be provided by the affidavit of the person claiming to be such holder, or by a certificate executed by any trust company, bank, banker, or any other depository wherever situated showing that at the date therein mentioned such person had on deposit with such trust company, bank, banker, or other depository, the Bonds or Additional Bonds described in such certificate. The District may conclusively assume that such ownership continues until written notice to the contrary is served upon the District. All matters relating to the ownership of registered Bonds and Additional Bonds shall be determined from the bond registration books kept by the registrar therefor.

Section 25. DAMAGED, MUTILATED, LOST, STOLEN, OR DESTROYED SERIES 2015A BONDS. (a) Replacement Bonds. In the event any outstanding Series 2015A Bond is damaged, mutilated, lost, stolen, or destroyed, the Paying Agent/Registrar shall cause to be printed, executed, and delivered, a new bond of the same principal amount, maturity, and interest rate, as the damaged, mutilated, lost, stolen, or destroyed Bond, in replacement for such Series 2015A Bond in the manner hereinafter provided.

(b) Application for Replacement Bonds. Application for replacement of damaged, mutilated, lost, stolen, or destroyed Series 2015A Bonds shall be made by the registered owner thereof to the Paying Agent/Registrar. In every case of loss, theft, or destruction of a Series 2015A Bond, the registered owner applying for a replacement bond shall furnish to the Issuer and to the Paying Agent/Registrar such security or indemnity as may be required by them to save each of them harmless from any loss or damage with respect thereto. Also, in every case of loss, theft, or destruction of a Series 2015A Bond, the registered owner shall furnish to the Issuer and to the Paying Agent/Registrar evidence to their satisfaction of the loss, theft, or destruction of such Series 2015A Bond, as the case may be. In every case of damage or mutilation of a Series 2015A Bond, the registered owner shall surrender to the Paying Agent/Registrar for cancellation the Series 2015A Bond so damaged or mutilated.

(c) No Default Occurred. Notwithstanding the foregoing provisions of this Section, in the event any such Series 2015A Bond shall have matured, and no default has occurred which is then continuing in the payment of the principal of, redemption premium, if any, or interest on the Series 2015A Bond, the Issuer may authorize the payment of the same (without surrender thereof except in the case of a damaged or mutilated Series 2015A Bond) instead of issuing a replacement Series 2015A Bond, provided security or indemnity is furnished as above provided in this Section.

(d) Charge for Issuing Replacement Bonds. Prior to the issuance of any replacement bond, the Paying Agent/Registrar shall charge the registered owner of such Series 2015A Bond with all legal, printing, and other expenses in connection therewith. Every replacement bond issued pursuant to the provisions of this Section by virtue of the fact that any Series 2015A Bond is lost, stolen, or destroyed shall constitute a contractual obligation of the Issuer whether or not the lost, stolen, or destroyed Series 2015A Bond shall be found at any time, or be enforceable by anyone, and

shall be entitled to all the benefits of this Resolution equally and proportionately with any and all other Series 2015A Bonds duly issued under this Resolution.

(e) Authority for Issuing Replacement Bonds. In accordance with Chapter 1201, Texas Government Code, this Section of this Resolution shall constitute authority for the issuance of any such replacement bond without necessity of further action by the governing body of the Issuer or any other body or person, and the duty of the replacement of such bonds is hereby authorized and imposed upon the Paying Agent/Registrar, and the Paying Agent/Registrar shall authenticate and deliver such Series 2015A Bonds in the form and manner and with the effect, as provided in this Resolution for Series 2015A Bonds issued in conversion and exchange for other Series 2015A Bonds.

Section 26. CUSTODY, APPROVAL, AND REGISTRATION OF SERIES 2015A BONDS; BOND COUNSEL'S OPINION, CUSIP NUMBERS, AND PREAMBLE. The President of the Board of Directors of the Issuer is hereby authorized to have control of the Initial Bond issued hereunder and all necessary records and proceedings pertaining to said Initial Bond pending its delivery and its investigation, examination, and approval by the Attorney General of the State of Texas, and its registration by the Comptroller of Public Accounts of the State of Texas. Upon registration of said Initial Bond said Comptroller of Public Accounts (or a deputy designated in writing to act for said Comptroller) shall manually sign the Comptroller's Registration Certificate on said Initial Bond, and the seal of said Comptroller shall be impressed, or placed in facsimile, on said Initial Bond. The approving legal opinion of the Issuer's Bond Counsel and the assigned CUSIP numbers may, at the option of the Issuer, be printed on said Initial Bond or on any Series 2015A Bonds issued and delivered in conversion of and exchange or replacement of any Series 2015A Bond, but neither shall have any legal effect, and shall be solely for the convenience and information of the registered owners of the Series 2015A Bonds. The preamble to this Resolution is hereby adopted and made a part hereof for all purposes.

Section 27. COVENANTS REGARDING TAX EXEMPTION. (a) Covenants. The Issuer covenants to take any action necessary to assure, or refrain from any action that would adversely affect, the treatment of the Series 2015A Bonds as obligations described in section 103 of the Internal Revenue Code of 1986, as amended (the "Code"), the interest on which is not includable in the "gross income" of the Series 2015A Bonds holder for purposes of federal income taxation. In furtherance thereof, the Issuer covenants as follows:

(1) to take any action to assure that no more than 10 percent of the proceeds of the Series 2015A Bonds (less amounts deposited to a reserve fund, if any) are used for any "private business use," as defined in section 141(b)(6) of the Code or, if more than 10 percent of the proceeds or the projects financed therewith are so used, such amounts, whether or not received by the Issuer, with respect to such private business use, do not, under the terms of this Resolution or any underlying arrangement, directly or indirectly, secure or provide for the payment of more than 10 percent of the debt service on the Series 2015A Bonds, in contravention of section 141(b)(2) of the Code;

(2) to take any action to assure that in the event that the "private business use" described in subsection (1) hereof exceeds 5 percent of the proceeds of the Series 2015A

Bonds or the projects financed therewith (less amounts deposited into a reserve fund, if any) then the amount in excess of 5 percent is used for a "private business use" that is "related" and not "disproportionate," within the meaning of section 141(b)(3) of the Code, to the governmental use;

(3) to take any action to assure that no amount that is greater than the lesser of $5,000,000, or 5 percent of the proceeds of the Series 2015A Bonds (less amounts deposited into a reserve fund, if any) is directly or indirectly used to finance loans to persons, other than state or local governmental units, in contravention of section 141(c) of the Code;

(4) to refrain from taking any action that would otherwise result in the Series 2015A Bonds being treated as "private activity bonds" within the meaning of section 141(b) of the Code;

(5) to refrain from taking any action that would result in the Series 2015A Bonds being "federally guaranteed" within the meaning of section 149(b) of the Code;

(6) to refrain from using any portion of the proceeds of the Series 2015A Bonds, directly or indirectly, to acquire or to replace funds that were used, directly or indirectly, to acquire investment property (as defined in section 148(b)(2) of the Code) that produces a materially higher yield over the term of the Series 2015A Bonds, other than investment property acquired with –

(A) proceeds of the Series 2015A Bonds invested for a reasonable temporary period of 3 years or less or, in the case of a refunding bond, for a period of 90 days or less until such proceeds are needed for the purpose for which the Series 2015A Bonds are issued,

(B) amounts invested in a bona fide debt service fund, within the meaning of section 1.148-1(b) of the Treasury Regulations, and

(C) amounts deposited in any reasonably required reserve or replacement fund to the extent such amounts do not exceed 10 percent of the proceeds of the Series 2015A Bonds;

(7) to otherwise restrict the use of the proceeds of the Series 2015A Bonds or amounts treated as proceeds of the Series 2015A Bonds, as may be necessary, so that the Series 2015A Bonds do not otherwise contravene the requirements of section 148 of the Code (relating to arbitrage) and, to the extent applicable, section 149(d) of the Code (relating to advance refundings);

(8) to pay to the United States of America at least once during each five-year period (beginning on the date of delivery of the Series 2015A Bonds) an amount that is at least equal to 90 percent of the "Excess Earnings," within the meaning of section 148(f) of the Code and to pay to the United States of America, not later than 60 days after the Series

2015A Bonds have been paid in full, 100 percent of the amount then required to be paid as a result of Excess Earnings under section 148(f) of the Code; and

(b) Rebate Fund. In order to facilitate compliance with the above covenant (a)(8), a "Rebate Fund" is hereby established by the Issuer for the sole benefit of the United States of America, and such Fund shall not be subject to the claim of any other person, including without limitation the Bondholders. The Rebate Fund is established for the additional purpose of compliance with section 148 of the Code.

(c) Compliance with Code. For purposes of the foregoing covenants (a)(1) and (a)(2), the Issuer understands that the term "proceeds" includes "disposition proceeds" as defined in the Treasury Regulations and, in the case of refunding Series 2015A Bonds, transferred proceeds (if any) and proceeds of the refunded Series 2015A Bonds expended prior to the date of issuance of the refunding Series 2015A Bonds. It is the understanding of the Issuer that the covenants contained herein are intended to assure compliance with the Code and any regulations or rulings promulgated by the U.S. Department of the Treasury pursuant thereto. In the event that regulations or rulings are hereafter promulgated that modify or expand provisions of the Code, as applicable to the Series 2015A Bonds, the Issuer will not be required to comply with any covenant contained herein to the extent that such failure to comply, in the opinion of nationally recognized bond counsel, will not adversely affect the exemption from federal income taxation of interest on the Series 2015A Bonds under section 103 of the Code. In the event that regulations or rulings are hereafter promulgated that impose additional requirements applicable to the Series 2015A Bonds, the Issuer agrees to comply with the additional requirements to the extent necessary, in the opinion of nationally recognized bond counsel, to preserve the exemption from federal income taxation of interest on the Series 2015A Bonds under section 103 of the Code. In furtherance of such intention, the Issuer hereby authorizes and directs the President of the Board of Directors, the General Manager, or the Director of Finance to execute any documents, certificates or reports required by the Code and to make such elections, on behalf of the Issuer, that may be permitted by the Code as are consistent with the purpose for the issuance of the Series 2015A Bonds.

(d) Written Procedures. Unless superseded by another action of the Issuer to ensure compliance with the covenants contained herein regarding private business use, remedial actions, arbitrage and rebate, the Issuer hereby adopts and establishes the instructions attached hereto as Exhibit A as their written procedures applicable to the Bonds and any Additional Bonds.

Section 28. ALLOCATION OF, AND LIMITATION ON, EXPENDITURES FOR THE PROJECT. The Issuer covenants to account for the expenditure of sale proceeds and investment earnings to be used for the purposes described in Section 1 of this Resolution (the "Project") on its books and records by allocating proceeds to expenditures within 18 months of the later of the date that (1) the expenditure is made, or (2) the Project is completed. The foregoing notwithstanding, the Issuer shall not expend sale proceeds or investment earnings thereon more than 60 days after the earlier of (1) the fifth anniversary of the delivery of the Series 2015A Bonds, or (2) the date the Series 2015A Bonds are retired, unless the Issuer obtains an opinion of nationally-recognized bond counsel that such expenditure will not adversely affect the tax-exempt status of the Series 2015A Bonds. For purposes hereof, the Issuer shall not be obligated to comply with this covenant if it

obtains an opinion that such failure to comply will not adversely affect the excludability for federal income tax purposes from gross income of the interest.

Section 29. DISPOSITION OF PROJECT. The Issuer covenants that the property constituting the Project will not be sold or otherwise disposed in a transaction resulting in the receipt by the Issuer of cash or other compensation, unless the Issuer obtains an opinion of nationally-recognized bond counsel that such sale or other disposition will not adversely affect the tax-exempt status of the Series 2015A Bonds. For purposes of the foregoing, the portion of the property comprising personal property and disposed in the ordinary course shall not be treated as a transaction resulting in the receipt of cash or other compensation. For purposes hereof, the Issuer shall not be obligated to comply with this covenant if it obtains an opinion that such failure to comply will not adversely affect the excludability for federal income tax purposes from gross income of the interest.

Section 30. CONTINUING DISCLOSURE. (a) Definitions. As used in this Section, the following terms have the meanings ascribed to such terms below:

"*Authority*" means Trinity River Authority.

"*Cities*" means the Cities of Arlington, Fort Worth and Mansfield.

"*MSRB*" means the Municipal Securities Rulemaking Board.

"*Rule*" means SEC Rule 15c2-12, as amended from time to time.

"*SEC*" means the United States Securities and Exchange Commission.

(b) General. Pursuant to a Continuing Disclosure Agreement by and among the Issuer, the Cities, and the Authority, the Issuer, the Cities and the Authority have undertaken for the benefit of the beneficial owners of the Series 2015A Bonds, to the extent set forth therein, to provide continuing disclosure of financial information and operating data with respect to the Issuer, Cities and Authority in accordance with the Rule as promulgated by the SEC.

(c) Annual Reports. (i) The Issuer shall provide annually to the MSRB, within six months after the end of each fiscal year ending in or after 2015, financial information and operating data with respect to the Issuer of the general type described in Exhibit B hereto. Any financial statements so to be provided shall be prepared in accordance with the accounting principles described in Exhibit B thereto, or such other accounting principles as the Issuer may be required to employ from time to time pursuant to state law or regulation, and audited, if the Issuer commissions an audit of such statements and the audit is completed within the period during which they must be provided. If the audit of such financial statements is not complete within such period, then the Issuer shall provide audited financial statements for the applicable fiscal year to the MSRB, when and if the audit report on such statements become available.

(ii) If the Issuer changes its fiscal year, it will notify the MSRB of the change (and of the date of the new fiscal year end) prior to the next date by which the Issuer otherwise would be required to provide financial information and operating data pursuant to this Section. The financial

information and operating data to be provided pursuant to this Section may be set forth in full in one or more documents or may be included by specific reference to any document (including an official statement or other offering document, if it is available from the MSRB) that theretofore has been provided to the MSRB, or filed with the SEC.

(d) Disclosure Event Notices. The Issuer shall notify the MSRB, in a timely manner, of any of the following events with respect to the Series 2015A Bonds, not in excess of ten Business Days after occurrence of the event:

1. Principal and interest payment delinquencies;

2. Non-payment related defaults, if material;

3. Unscheduled draws on debt service reserves reflecting financial difficulties;

4. Unscheduled draws on credit enhancements reflecting financial difficulties;

5. Substitution of credit or liquidity providers, or their failure to perform;

6. Adverse tax opinions, the issuance by the Internal Revenue Service of proposed or final determinations of taxability, Notices of Proposed Issue (IRS Form 5701-TEB) or other material notices or determinations with respect to the tax status of the security, or other material events affecting the tax status of the security;

7. Modifications to the rights of security holders, if material;

8. Bond calls, if material, and tender offers;

9. Defeasances;

10. Release, substitution or sale of property securing repayment of the securities, if material;

11. Rating changes;

12. Bankruptcy, insolvency, receivership or similar event of the Issuer, any of the Cities or the Authority;

13. The consummation of a merger, consolidation, or acquisition involving the Issuer or the sale of all or substantially all of the assets of the Issuer, any of the Cities, or the Authority, other than in the ordinary course of business, the entry into a definitive agreement to undertake such an action or the termination of a definitive agreement relating to any such actions, other than pursuant to its terms, if material; and

14. Appointment of a successor or additional trustee or the change of name of a trustee, if material.

The Issuer shall notify the MSRB, in a timely manner, of any failure by the Issuer to provide financial information or operating data in accordance with Section 30(c) of this Resolution by the time required by such Section. As used in clause 12 above, the phrase "bankruptcy, insolvency, receivership or similar event" means the appointment of a receiver, fiscal agent, or similar officer for the Issuer in a proceeding under the U.S. Bankruptcy Code or in any other proceeding under state or federal law in which a court or governmental authority has assumed jurisdiction over substantially all of the assets or business of the Issuer, or if jurisdiction has been assumed by leaving the Board of Directors and official or officers of the Issuer in possession but subject to the supervision and orders of a court or governmental authority, or the entry of an order confirming a plan of reorganization, arrangement or liquidation by a court or governmental authority having supervision or jurisdiction over substantially all of the assets or business of the Issuer.

(e) Limitations, Disclaimers, and Amendments. (i) The Issuer shall be obligated to observe and perform the covenants specified in this Section for so long as, but only for so long as, the Issuer remains an "obligated person" with respect to the Series 2015A Bonds within the meaning of the Rule, except that the Issuer in any event will give notice of any deposit made in accordance with this Resolution or applicable law that causes Series 2015A Bonds no longer to be outstanding.

(ii) The provisions of this Section are for the sole benefit of the holders and beneficial owners of the Series 2015A Bonds, and nothing in this Section, express or implied, shall give any benefit or any legal or equitable right, remedy, or claim hereunder to any other person. The Issuer undertakes to provide only the financial information, operating data, financial statements, and notices which it has expressly agreed to provide pursuant to this Section and does not hereby undertake to provide any other information that may be relevant or material to a complete presentation of the Issuer's financial results, condition, or prospects or hereby undertake to update any information provided in accordance with this Section or otherwise, except as expressly provided herein. The Issuer does not make any representation or warranty concerning such information or its usefulness to a decision to invest in or sell Series 2015A Bonds at any future date.

(iii) UNDER NO CIRCUMSTANCES SHALL THE ISSUER BE LIABLE TO THE HOLDER OR BENEFICIAL OWNER OF ANY SERIES 2015A BOND OR ANY OTHER PERSON, IN CONTRACT OR TORT, FOR DAMAGES RESULTING IN WHOLE OR IN PART FROM ANY BREACH BY THE ISSUER, WHETHER NEGLIGENT OR WITHOUT FAULT ON ITS PART, OF ANY COVENANT SPECIFIED IN THIS SECTION, BUT EVERY RIGHT AND REMEDY OF ANY SUCH PERSON, IN CONTRACT OR TORT, FOR OR ON ACCOUNT OF ANY SUCH BREACH SHALL BE LIMITED TO AN ACTION FOR MANDAMUS OR SPECIFIC PERFORMANCE.

(iv) No default by the Issuer in observing or performing its obligations under this Section shall comprise a breach of or default under this Resolution for purposes of any other provision of this Resolution. Nothing in this Section is intended or shall act to disclaim, waive, or otherwise limit the duties of the Issuer under federal and state securities laws.

(v) The provisions of this Section may be amended by the Issuer from time to time to adapt to changed circumstances that arise from a change in legal requirements, a change in law, or a change in the identity, nature, status, or type of operations of the Issuer, but only if (1) the provisions

of this Section, as so amended, would have permitted an underwriter to purchase or sell Series 2015A Bonds in the primary offering of the Series 2015A Bonds in compliance with the Rule, taking into account any amendments or interpretations of the Rule since such offering as well as such changed circumstances and (2) either (a) the holders of a majority in aggregate principal amount (or any greater amount required by any other provision of this Resolution that authorizes such an amendment) of the Outstanding Series 2015A Bonds consent to such amendment or (b) a person that is unaffiliated with the Issuer (such as bond counsel) determines that such amendment will not materially impair the interest of the holders and beneficial owners of the Series 2015A Bonds. If the Issuer so amends the provisions of this Section, it shall include with any amended financial information or operating data next provided in accordance with subsection (a) of this Section an explanation, in narrative form, of the reason for the amendment and of the impact of any change in the type of financial information or operating data so provided. The Issuer may also amend or repeal the provisions of this continuing disclosure agreement if the SEC amends or repeals the applicable provision of the Rule or a court of final jurisdiction enters judgment that such provisions of the Rule are invalid, but only if and to the extent that the provisions of this sentence would not prevent an underwriter from lawfully purchasing or selling Series 2015A Bonds in the primary offering of the Series 2015A Bonds.

Section 31. INTEREST EARNINGS ON SERIES 2015A BOND PROCEEDS. Interest earnings derived from the investment of proceed from the sale of the Series 2015A Bonds shall be used along with other bond proceeds from the acquisition and consruction of the Project; provided that afer completion of the Project, if any of such interest earnings remain on hand, such interest earnings shall be deposited in the Interest and Redemption fund. It is further provided, however, that any interest earnings on bond proceeds which are required to be rebated to the United States of America pursuant to this Resolution in order to prevent the Series 2015A Bonds from being arbitrage bonds shall be so rebated and not considered as interest earnings for the purposes of this Section.

Section 32. ESCROW AGREEMENT. If required by the TWDB as a condition to the purchase of the Bonds, the President, any Vice President, the Secretary, and/or the General Manager is authorized to execute and deliver an escrow agreement in substantially the form attached as Exhibit C. In such case, proceeds of the Bonds required to be deposited under an escrow agreement shall be disposed of and released in accordance with TWDB Rules Relating to Financial Programs or as otherwise authorized and directed by the TWDB.

Section 33. SALE OF SERIES 2015A BONDS. The Series 2015A Bonds are hereby sold and shall be delivered to the TWDB at a purchase price equal to 100% of the principal amount thereof. The officers of the Issuer are authorized to do any and all things necessary in connection with the issuance of the Series 2015A Bonds, and are authorized to execute and deliver such certificates as are necessary or appropriate in connection with the issuance of the Series 2015A Bonds. It is hereby officially found, determined, and declared that the terms of this sale are the most advantageous reasonably obtainable. The Initial Bond shall be registered in the name of the TWDB or its designee.

Section 34. TWDB REQUIREMENTS. The Issuer covenants and agrees, so long as the TWDB owns all of the Series 2015A Bonds, as follows:

(a) FINAL ACCOUNTING. The Issuer shall render a final accounting to the TWDB in reference to the total costs incurred by the Issuer with proceeds of the Series 2015A Bonds.

(b) SURPLUS BOND PROCEEDS. To the extent that any proceeds of the Series 2015A Bonds remain after payment of all costs to be paid with proceeds of the Series 2015A Bonds, such surplus proceeds shall be used to purchase or redeem and cancel the Series 2015A Bonds, in inverse order of their maturity, owned by the TWDB; provided that any remaining amounts less than $5,000 shall be deposited to the Interest and Sinking Fund.

(c) ANNUAL REPORTS. Annual audits of the Issuer required by Section 23(k) hereof shall be delivered to the TWDB within 120 days of the close of each fiscal year.

(d) COMPLIANCE WITH THE TWDB'S RULES AND REGULATIONS. The Issuer shall comply with the rules and regulations of the TWDB, and shall maintain any insurance, in addition to that required by Section 23(h) of this Resolution, on the District's Water System in an amount determined by the TWDB to be sufficient to protect the TWDB's interest. Additionally, the Issuer covenants to invest the proceeds received from the sale of the Series 2015A Bonds only in accordance with the Public Funds Investment Act, Chapter 2256, Texas Government Code, as amended, and to secure such proceeds as required by the Public Securities Collateral Act, Chapter 2257, Texas Government Code, as amended.

(e) CONSTRUCTION FUND. The Issuer shall maintain on its books a Construction Fund, separate and apart from all other funds of the District, into which it shall deposit and disburse proceeds of the Series 2015A Bonds (except for any proceeds required by this Resolution to be deposited into the Interest and Redemption Fund and the Reserve Fund).

(f) ENVIRONMENTAL INDEMNIFICATION. The Issuer agrees to indemnify, hold harmless, and protect the TWDB from any and all claims, causes of action or damages to the person or property of third parties arising from the sampling, analysis, transport and/or removal and disposition of any contaminated sewage sludge, contaminated sediments and/or contaminated media that may be generated by the Issuer, its contractors, consultants, agents, officials and employees as a result of activities relating to the project financed with proceeds of the Series 2015A Bonds to the extent permitted by law.

(g) WATER CONSERVATION PLAN. The Issuer will implement and/or assist in the implementation of water conservation plans approved by the TWDB.

Section 35. ATTORNEY GENERAL FEES. The Issuer hereby authorizes and directs payment, from legally available funds of the Issuer, of the nonrefundable examination fee of the Attorney General of the State of Texas required by Section 1202.004, Texas Government Code, as amended.

Section 36. FURTHER PROCEDURES. The President and the Secretary of the Board of Directors and the General Manager and the Finance Director of the Issuer, and all other officers, employees, and agents of the Issuer, and each of them, shall be and they are hereby expressly authorized, empowered, and directed from time to time and at any time to do and perform all such

acts and things and to execute, acknowledge, and deliver in the name and on behalf of the Issuer all such instruments, whether or not herein mentioned, as may be necessary or desirable in order to carry out the terms and provisions of this Resolution, and all details in connection therewith. In case any officer whose signature shall appear on any Series 2015A Bond shall cease to be such officer before the delivery of such Series 2015A Bond, such signature shall nevertheless be valid and sufficient for all purposes the same as if such officer had remained in office until such delivery.

Section 37. REPEAL OF CONFLICTING RESOLUTIONS. All resolutions and all parts of any resolutions which are in conflict or inconsistent with this Resolution are hereby repealed and shall be of no further force or effect to the extent of such conflict or inconsistency.

Section 38. PUBLIC NOTICE. It is hereby officially found and determined that public notice of the time, place and purpose of said meeting was given, all as required by the Government Code, Chapter 551.

EXHIBIT "A"

WRITTEN PROCEDURES RELATING TO CONTINUING
COMPLIANCE WITH FEDERAL TAX COVENANTS

A. Arbitrage. With respect to the investment and expenditure of the proceeds of the Series 2015A Bonds and any Additional Bonds (the "Obligations") the Issuer's General Manager, Assistant General Manager, and Director of Finance (the "Responsible Persons") will :

For Obligations issued for newly acquired property or constructed property:

- instruct the appropriate person or persons that the construction, renovation or acquisition of the facilities must proceed with due diligence and that binding contracts for the expenditure of at least 5%of the proceeds of the Obligations will be entered into within 6 months of the Issue Date;
- monitor that at least 85% of the proceeds of the Obligations to be used for the construction, renovation or acquisition of any facilities are expended within 3 years of the date of delivery of the Obligations ("Issue Date");
- restrict the yield of the investments (other than those in the Reserve Fund) to the yield on the Obligations after 3 years of the Issue Date;
- monitor all amounts deposited into a sinking fund or funds, e.g., the Interest and Redemption Fund and the Reserve Fund, to assure that the maximum amount invested at a yield higher than the yield on the Obligations does not exceed an amount equal to the debt service on the Obligations in the succeeding 12 month period plus a carryover amount equal to one-twelfth of the principal and interest payable on the Obligations for the immediately preceding 12-month period;
- assure that no more than 50% of the proceeds of the Obligations are invested in an investment with a guaranteed yield for 4 years or more;
- assure that the maximum amount of the Reserve Fund invested at a yield higher than the yield on the Obligations will not exceed the lesser of (1) 10% of the original principal amount of the Obligations, (2) 125% of the average annual debt service on the Obligations measured as of the Issue Date, or (3) 100% of the maximum annual debt service on the Obligations as of the Issue Date;

For Obligations issued for refunding purposes:

- monitor the actions of the escrow agent (to the extent an escrow is funded with proceeds) to assure compliance with the applicable provisions of the escrow agreement, including with respect to reinvestment of cash balances;

For all Obligations:

- maintain any official action of the Issuer (such as a reimbursement resolution) stating its intent to reimburse itself or the City with the proceeds of the Obligations any amount expended prior to the Issue Date for the acquisition, renovation or construction of the facilities;

- assure that the applicable information return (e.g., IRS Form 8038-G, 8038-GC, or any successor forms) is timely filed with the IRS;

- assure that, unless excepted from rebate and yield restriction under section 148(f) of the Code, excess investment earnings are computed and paid to the U.S. government at such time and in such manner as directed by the IRS (i) at least every 5 years after the Issue Date and (ii) within 30 days after the date the Obligations are retired.

B. Private Business Use. With respect to the use of the facilities financed or refinanced with the proceeds of the Obligations the Responsible Persons will:

- monitor the date on which the facilities are substantially complete and available to be used for the purpose intended;

- monitor whether, at any time the Obligations are outstanding, any person, other than the Issuer or the City, the employees of the Issuer or the City, the agents of the Issuer or the City or members of the general public has any contractual right (such as a lease, purchase, management or other service agreement) with respect to any portion of the facilities;

- monitor whether, at any time the Obligations are outstanding, any person, other than the Issuer or the City, the employees of the Issuer or the City, the agents of the Issuer or the City or members of the general public has a right to use the output of the facilities (e.g., water, gas, electricity);

- monitor whether, at any time the Obligations are outstanding, any person, other than the Issuer or the City, the employees of the Issuer or the City, the agents of the Issuer or the City or members of the general public has a right to use the facilities to conduct or to direct the conduct of research;

- determine whether, at any time the Obligations are outstanding, any person, other than the Issuer or the City, has a naming right for the facilities or any other contractual right granting an intangible benefit;

- determine whether, at any time the Obligations are outstanding, the facilities are sold or otherwise disposed of; and

- take such action as is necessary to remediate any failure to maintain compliance with the covenants contained in the resolution authorizing the Obligations.

C. Record Retention. The Responsible Persons will maintain or cause to be maintained all records relating to the investment and expenditure of the proceeds of the Obligations and the use of the facilities financed or refinanced

thereby for a period ending three (3) years after the complete extinguishment of the Obligations. If any portion of the Obligations is refunded with the proceeds of another series of tax-exempt obligations, such records shall be maintained until the three (3) years after the refunding obligations are completely extinguished. Such records can be maintained in paper or electronic format.

D. Responsible Persons. Each Responsible Person shall receive appropriate training regarding the Issuer's accounting system, contract intake system, facilities management and other systems necessary to track the investment and expenditure of the proceeds and the use of the facilities financed with the proceeds of the Obligations. The foregoing notwithstanding, the Responsible Persons are authorized and instructed to retain such experienced advisors and agents as may be necessary to carry out the purposes of these instructions.

EXHIBIT "B"

DESCRIPTION OF ANNUAL FINANCIAL INFORMATION

The following information is referred to in Section 30 of this Resolution.

I. Annual Financial Statements and Operating Data of the Issuer

The financial information and operating data with respect to the Issuer to be provided annually in accordance with such Section are as specified.

Accounting Principles

The accounting principles referred to in such Section are the accounting principles described in the notes to the financial statements referred to in paragraph 1 above.

EXHIBIT "C"

ESCROW AGREEMENT

PRIVATE PLACEMENT MEMORANDUM DATED _____, 2015

NEW ISSUE BOOK-ENTRY-ONLY

On the date of initial delivery of the Obligations (defined below), Issuer Bond Counsel (defined on page 2) will render its opinion substantially in the form attached in APPENDIX C - FORM OF OPINION OF BOND COUNSEL.

$300,000,000
TARRANT REGIONAL WATER DISTRICT,
A WATER CONTROL AND IMPROVEMENT DISTRICT,
WATER REVENUE BONDS, SERIES 2015A
(the "Obligations")

Dated: _____, 2015 **Due: March 1**

Interest Date:	Interest on the Obligations will be payable on March 1, 2016, and on each September 1 and March 1 each year thereafter until maturity or prior redemption (each an "Interest Payment Date"). The Obligations will bear interest at the rates per annum set forth in "APPENDIX A - MATURITY SCHEDULE."
Record Date:	The close of business on the fifteenth business day of the calendar month immediately preceding the applicable Interest Payment Date.
Date Interest Accrues:	Each Bond shall bear interest from the Delivery Date thereof or the most recent Interest Payment Date to which interest has been paid or provided for at the rate set forth, such maturity.
Redemption:	The Obligations are subject to redemption prior to maturity as provided herein. See "THE OBLIGATIONS - Redemption Provisions" herein.
Authorized Denominations:	The Obligations are being issued as fully registered bonds in denominations of $5,000, or any integral multiple thereof.
Paying Agent/Registrar/Registrar:	The paying agent ("Paying Agent/Registrar/Registrar") for the Obligations is BOKF, NA dba Bank of Texas, Austin, Texas.
Book-Entry-Only System	Upon initial issuance, the ownership of the Obligations will be registered in the registration books of Tarrant Regional Water District (the "Issuer") kept by the Paying Agent/Registrar, in the name of Cede & Co., as nominee of The Depository Trust Company, New York, New York ("DTC") to which principal, redemption premium, if any, and interest payments on the Obligations will be made. The purchasers of the Obligations will not receive physical delivery of bond certificates. Principal of, interest, and premium if any, on the Obligations will be payable at the designated office of the Paying Agent/Registrar in Austin, Texas as the same become due and payable.
Issuer:	Tarrant Regional Water District, a Water Control and Improvement District, created and functioning under Article 16, Section 59, of the Texas Constitution, pursuant to the general laws of the State of Texas, including Chapters 49 and 51, Texas Water Code, and pursuant to the provisions of Chapter 268, Acts of 1957, 55th Legislature of Texas, Regular Session, as amended (collectively, the "District Act").
Official Action:	Resolution Authorizing the Issuance, Sale and Delivery of Tarrant Regional Water District, a Water Control and Improvement District, Water System Revenue Bonds, Series 2015A, dated _____,2015.
Purpose:	The Obligations are being issued for the purpose of (i) to pay for construction, improvements, and extensions to the District's Water System, including design, acquisition, and construction of an integrated pipeline to serve the City of Dallas and the District; (ii) to fund a debt service reserve fund; and (iii) to pay costs of issuance of the Series 2015A Bonds.
Security for the Obligations:	See "SECTION ___ PLEDGE" OF "APPENDIX B – FORM OF OFFICIAL ACTION."
Ratings:	See "OTHER INFORMATION - Ratings"
Delivery Date:	_____, 2015.

See "APPENDIX A - MATURITY SCHEDULE" for Principal Amounts,

Maturities, Interest Rates, Prices or Yields, and Initial CUSIP Numbers

TARRANT REGIONAL WATER DISTRICT
A WATER CONTROL AND IMPROVEMENT DISTRICT

BOARD OF DIRECTORS

Victor W. Henderson ..... President

Jack R. Stevens ..... Vice President

Martha V. Leonard ..... Secretary

James W. Lane. ..... Secretary Pro Tem

Mary Kelleher ..... Director

MANAGEMENT OFFICERS

James M. Oliver ..... General Manager

Alan Thomas ..... Deputy General Manager

Sandra Newby ..... Finance Director

McCall, Parkhurst & Horton L.L.P., Co-Bond Counsel
Newby Davis PLLC, Co-Bond Counsel

First Southwest Company, LLC, Co-Financial Advisor
Kipling Jones & Co., Co- Financial Advisor

BOKF, NA dba Bank of Texas, Paying Agent/Registrar

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Private Placement Memorandum
relating to

$300,000,000

TARRANT REGIONAL WATER DISTRICT,
A WATER CONTROL AND IMPROVEMENT DISTRICT,
WATER REVENUE BONDS, SERIES 2015A
(the "Obligations")

INTRODUCTION

This Private Placement Memorandum, including the cover page and appendices, contains brief descriptions of the Issuer, provides certain information with respect to the issuance by the Issuer, and summaries of certain provisions of the "Obligations" pursuant to the Official Action. Except as otherwise set forth herein, capitalized terms used but not defined in this Private Placement Memorandum have the meanings assigned to them in the Official Action. See "APPENDIX B – "FORM OF OFFICIAL ACTION" attached hereto.

APPENDIX A contains the maturity schedule for the Obligations. APPENDIX B contains the Official Action and a description of the purpose for the proceeds of the Obligations. APPENDIX C contains a copy of the proposed opinion of Bond Counsel with respect to the Obligations. The summaries of the documents contained in the forepart of this Private Placement Memorandum are not complete or definitive, and every statement made in this Private Placement Memorandum concerning any provision of any document is qualified by reference to such document in its entirety.

THE OBLIGATIONS

General Description

The Obligations are being issued in the aggregate principal amount set forth in APPENDIX A of this Private Placement Memorandum and will mature and be subject to redemption prior to maturity as described therein. The Obligations are being issued as fully registered bonds in denominations of $5,000**,** or any integral multiple thereof. The Obligations will be dated as of the stated date of issue and will mature on the dates referenced thereon, and will bear interest at the rates per annum set forth in "APPENDIX A - MATURITY SCHEDULE."

Interest on the Obligations is payable semiannually on each Interest Payment Date, and will be calculated on the basis of a 360-day year consisting of twelve 30-day months. Principal of and the redemption price with respect to the Obligations will be payable to the Owners upon presentation and surrender at the principal office of the Paying Agent/Registrar.

Purpose

See "APPENDIX B - FORM OF OFFICIAL ACTION."

Authority for Issuance

The Obligations are issued pursuant to the general laws of the State of Texas, including Chapters 49 and 51, Texas Water Code, as amended, pursuant to the provisions of the District Act, and pursuant to the Official Action.

Security for the Obligations

See "APPENDIX B - FORM OF OFFICIAL ACTION."

Redemption Provisions

On March 1, 2027, or on any date thereafter, the Obligations maturing on and after March 1, 2026 may be redeemed prior to their scheduled maturities, upon the written direction of the Issuer, with funds provided by the Issuer, at par plus accrued interest to the date fixed for redemption as a whole, or in part, and if less than all of a maturity is to be redeemed the Paying Agent/Registrar will determine by lot the Obligations, or portions thereof within such maturity to be redeemed (provided that a portion of a Bond may be redeemed only in Authorized Denominations).

Notice of Redemption; Selection of Obligations to Be Redeemed

See "APPENDIX B - FORM OF OFFICIAL ACTION."

The Paying Agent/Registrar, so long as a Book-Entry-Only System is used for the Bonds, will send any notice of redemption of the Bonds, notice of any proposed amendment to the Official Action or other notices with respect to the Bonds only to DTC. Any failure by DTC to advise any DTC Participant (defined below), or of any DTC participant to notify the beneficial owner, shall not affect the validity of the redemption of the Bonds called for redemption or any other action premised on any such notice. Redemption of portions of the Bonds by the Issuer will reduce the outstanding principal amount of such Bonds held by DTC.

Book-Entry-Only System

The information in this caption concerning The Depository Trust Company, New York, New York ("DTC") and DTC's book entry system has been obtained from DTC and the Issuer makes no representation or warranty nor takes any responsibility for the accuracy or completeness of such information.

DTC will act as securities depository for the Obligations. The Obligations will be issued as fully-registered securities registered in the name of Cede & Co. (DTC's partnership nominee) or such other name as may be requested by an authorized representative of DTC. One fully-registered certificate will be issued for each maturity of the Obligations and deposited with DTC. See APPENDIX B - "FORM OF OFFICIAL ACTION."

DTC is a limited-purpose trust company organized under the New York Banking Law, a "banking organization" within the meaning of the New York Banking Law, a member of the Federal Reserve System, a "clearing corporation" within the meaning of the New York Uniform Commercial Code, and a "clearing agency" registered pursuant to the provisions of Section 17A of the Securities Exchange Act of 1934. DTC holds and provides asset servicing for over 3.5 million issues of U.S. and non-U.S. equity, corporate and municipal debt issues, and money market instrument (from over 100 countries) that DTC's participants (the "Direct Participants") deposit with DTC. DTC also facilitates the post-trade settlement among Direct Participants of sales and other securities transactions, in deposited securities, through electronic computerized book entry transfers and pledges between Direct Participants' accounts. This eliminates the need for physical movement of securities certificates. Direct Participants include both U.S. and non-U.S. securities brokers and dealers, banks, trust companies, clearing corporations, and certain other organizations. DTC is a wholly-owned subsidiary of The Depository Trust & Clearing Corporation ("DTCC"). DTCC is the holding company for DTC, National Securities Clearance Corporation, and Fixed Income Clearance Corporation, all of which are registered clearing agencies. DTCC is owned by the users of its regulated subsidiaries. Access to the DTC system is also available to others such as both U.S. and non-U.S. securities brokers and dealers, banks, trust companies, and clearing corporations that clear through or maintain a custodial relationship with a Direct Participant, either directly or indirectly ("Indirect Participants"). Direct Participants and Indirect Participants are referred to herein collectively as "Participants". DTC has a Standard & Poor's rating of "AA+". The DTC Rules applicable to its Participants are on file with the Securities and Exchange Commission. More information about DTC can be found at www.dtcc.com and www.dtc.org.

Purchases of Obligations under the DTC system must be made by or through Direct Participants, which will receive a credit for the Obligations on DTC's records. The ownership interest of each actual purchaser of each Bond ("Beneficial Owner") is in turn to be recorded on the Participants' records. Beneficial Owners will not receive written confirmation from DTC of their purchase. Beneficial Owners are, however, expected to receive written confirmations providing details of the transaction, as well as periodic statements of their holdings, from the Participant through which the Beneficial Owner entered into the transaction.

Transfers of ownership interests in the Obligations are to be accomplished by entries made on the books of Participants acting on behalf of Beneficial Owners. Beneficial Owners will not receive Obligations representing their ownership interests in Obligations, except in the event that use of the book-entry system for the Obligations is discontinued.

To facilitate subsequent transfers, all Obligations deposited by Direct Participants with DTC are registered in the name of DTC's partnership nominee, Cede & Co., or such other name as may be requested by an authorized

representative of DTC. The deposit of Obligations with DTC and their registration in the name of Cede & Co. or such other DTC nominee do not effect any change in beneficial ownership. DTC has no knowledge of the actual Beneficial Owners of the Obligations; DTC's records reflect only the identity of the Direct Participants to whose accounts such Obligations are credited, which may or may not be the Beneficial Owners. The Participants will remain responsible for keeping account of their holdings on behalf of their customers.

Conveyance of notices and other communications by DTC to Direct Participants, by Direct Participants to Indirect Participants, and by Direct Participants and Indirect Participants to Beneficial Owners will be governed by arrangements among them, subject to any statutory or regulatory requirements as may be in effect from time to time.

Redemption notices shall be sent to DTC. If less than all of the Obligations within a maturity are being redeemed, DTC's practice is to determine by lot the amount of the interest of each Direct Participant in such maturity to be redeemed.

Neither DTC nor Cede & Co. (nor any other DTC nominee) will consent or vote with respect to Obligations unless authorized by a Direct Participant in accordance with DTC's Money Market Instrument Procedures. Under its usual procedures, DTC mails an Omnibus Proxy to the Issuer as soon as possible after the record date. The Omnibus Proxy assigns Cede & Co.'s consenting or voting rights to those Direct Participants to whose accounts Obligations are credited on the record date (identified in a listing attached to the Omnibus Proxy).

All payments on the Obligations will be made to Cede & Co., or such other nominee as may be requested by an authorized representative of DTC. DTC's practice is to credit Direct Participants' accounts upon DTC's receipt of funds and corresponding detail information from the Issuer or the Paying Agent/Registrar, on payable date in accordance with their respective holdings shown on DTC's records. Payments by Participants to Beneficial Owners will be governed by standing instructions and customary practices, as is the case with Obligations held for the accounts of customers in bearer form or registered in "street name," and will be the responsibility of such Participant and not of DTC, the Paying Agent/Registrar, or the Issuer, subject to any statutory or regulatory requirements as may be in effect from time to time. All payments to Cede & Co. (or such other nominee as may be requested by an authorized representative of DTC) are the responsibility of the Issuer or the Paying Agent/Registrar, disbursement of such payments to Direct Participants will be the responsibility of DTC, and disbursement of such payments to the Beneficial Owners will be the responsibility of Participants.

DTC may discontinue providing its services as depository with respect to the Obligations at any time by giving reasonable notice to the Issuer or the Paying Agent/Registrar. Under such circumstances, in the event that a successor depository is not obtained, Obligations are required to be printed and delivered.

With the consent of the Texas Water Development Board, the Issuer may decide to discontinue use of the system of book-entry-only transfers through DTC (or a successor securities depository). In that event, Obligations will be printed and delivered to DTC or successor securities depository.

TAX MATTERS

Opinion

Bond Counsel will deliver its opinion on the date of delivery of the Obligations substantially in the form as attached in "APPENDIX C - FORM OF OPINION OF BOND COUNSEL."

OTHER INFORMATION

Forward Looking Statements

The statements contained in this Private Placement Memorandum, including the cover page, appendices, and any other information or documents provided by the Issuer, that are not purely historical, are forward-looking statements, including statements regarding the Issuer's assumptions, expectations, hopes, intentions, or strategies regarding the future. Any of such assumptions, expectations or hopes could be inaccurate and, therefore, there can be no assurance that the forward-looking statements included herein will prove to be accurate. Holders of the Bonds should not place undue reliance on forward-looking statements. All forward-looking statements included in this Private Placement Memorandum are based on information available to the Issuer on the date hereof, and the Issuer

assumes no obligation to update any such forward-looking statements. It is important to note that the Issuer's actual results could differ materially from those in such forward-looking statements.

Ratings

The existing outstanding water system revenue bonds of the District are rated "AAA" by Standard & Poor's Ratings Services, a Standard & Poor's Financial Services LLC business, "AA" by Fitch Ratings and "Aa1" by Moody's Investors Service, Inc. An explanation of the significance of such ratings may be obtained from the company furnishing the rating. The ratings reflect only the respective views of such rating companies, and the District makes no representation as to the appropriateness of the ratings. There is no assurance that such ratings will continue for any given period of time, or that they will not be revised downward or withdrawn entirely by either or both of such rating companies, if in the judgment of either or both companies, circumstances so warrant. Any such downward revision or withdrawal of such ratings, by either of them, may have an adverse effect on the market price of the Obligations. **No application has been made to any rating agency or municipal bond insurance company for qualification of the Obligations for ratings or municipal bond insurance, respectively.**

LITIGATION

There is no litigation, proceeding, inquiry, or investigation pending by or before any court or other governmental authority or entity (or, to the best knowledge of the Issuer, threatened) that adversely affects the power, authority or obligation of the Issuer to deliver the Bonds, the security for, or the validity of, the Bonds or the financial condition of the Issuer. On the date of initial delivery of Bonds, the Issuer will execute and deliver a certificate of like effect to the purchaser of the Bonds.

CONTINUING DISCLOSURE OF INFORMATION

In the Official Action, the Issuer has made the following agreement for the benefit of the holders and beneficial owners of the Obligations. The Issuer is required to observe the agreement for so long as it remains obligated to advance funds to pay the Obligations. Under the agreement, the Issuer will be obligated to provide certain updated financial information and operating data, and timely notice of specified material events, to certain other information vendors. SEE APPENDIX B - "FORM OF OFFICIAL ACTION."

Compliance with Prior Undertakings

During the last five years, the Issuer believes it has complied in all material respects with all continuing disclosure agreements made by it in accordance with the Rule.

MISCELLANEOUS

Any statements made in this Private Placement Memorandum involving matters of opinion or of estimates, whether or not so expressly stated, are set forth as such and not as representations of fact, and no representation is made that any of the estimates will be realized. Neither this Private Placement Memorandum nor any statement that may have been made verbally or in writing is to be construed as a contract with the owners of the Obligations.

The information contained above is neither guaranteed as to accuracy or completeness nor to be construed as a representation by the Issuer. The information and expressions of opinion herein are subject to change without notice and neither the delivery of this Private Placement Memorandum nor any sale made hereunder is to create, under any circumstances, any implication that there has been no change in the affairs of the Issuer or the Issuer from the date hereof.

The Private Placement Memorandum is submitted in connection with the sale of the securities referred to herein and may not be reproduced or used, as a whole or in part, for any other purpose.

ADDITIONAL INFORMATION

The Private Placement Memorandum speaks only as of its date and the information contained herein is subject to change. Descriptions of the Obligations and the Official Action and any other agreements and documents contained herein constitute summaries of certain provisions thereof and do not purport to be complete.

APPENDIX A

MATURITY SCHEDULE **CUSIP Prefix: 876443** [1]
(Due March 1)

Amount	Maturity March 1,	Rate	Yield	CUSIP Suffix	Amount	Maturity March 1,	Rate	Yield	CUSIP Suffix
$ 7,100,000	2017				$ 10,050,000	2032			
7,180,000	2018				10,385,000	2033			
7,280,000	2019				10,735,000	2034			
7,395,000	2020				11,105,000	2035			
7,520,000	2021				11,490,000	2036			
7,665,000	2022				11,905,000	2037			
7,825,000	2023				12,330,000	2038			
8,000,000	2024				12,770,000	2039			
8,185,000	2025				13,225,000	2040			
8,390,000	2026				13,700,000	2041			
8,620,000	2027				14,200,000	2042			
8,870,000	2028				14,715,000	2043			
9,140,000	2029				15,255,000	2044			
9,425,000	2030				15,810,000	2045			
9,730,000	2031								

(1) CUSIP is a registered trademark of the American Bankers Association. CUSIP data is provided by CUSIP Global Services, managed by Standard & Poor's Financial Services LLC on behalf of the American Bankers Association. This data is not intended to create a database and does not serve in any way as a substitute for the CUSIP services. Neither the Issuer nor the Co-Financial Advisors take any responsibility for the accuracy of CUSIP numbers.

APPENDIX B

FORM OF OFFICIAL ACTION

APPENDIX C

FORM OF OPINION OF BOND COUNSEL

PRIVATE PLACEMENT MEMORANDUM DATED _____, 2015

NEW ISSUE BOOK-ENTRY-ONLY

On the date of initial delivery of the Obligations (defined below), Issuer Bond Counsel (defined on page 2) will render its opinion substantially in the form attached in APPENDIX C - FORM OF OPINION OF BOND COUNSEL.

$140,000,000
TARRANT REGIONAL WATER DISTRICT,
A WATER CONTROL AND IMPROVEMENT DISTRICT,
WATER TRANSMISSION FACILITIES CONTRACT
REVENUE BONDS (CITY OF DALLAS PROJECT), SERIES 2015
(the "Obligations")

Dated: _____, 2015 **Due: September 1**

Interest Date:	Interest on the Obligations will be payable on March 1, 2016, and on each September 1 and March 1 each year thereafter until maturity or prior redemption (each an "Interest Payment Date"). The Obligations will bear interest at the rates per annum set forth in "APPENDIX A - MATURITY SCHEDULE."
Record Date:	The close of business on the fifteenth business day of the calendar month immediately preceding the applicable Interest Payment Date.
Date Interest Accrues:	Each Bond shall bear interest from the Delivery Date thereof or the most recent Interest Payment Date to which interest has been paid or provided for at the rate set forth, such maturity.
Redemption:	The Obligations are subject to redemption prior to maturity as provided herein. See "THE OBLIGATIONS - Redemption Provisions" herein.
Authorized Denominations:	The Obligations are being issued as fully registered bonds in denominations of $5,000, or any integral multiple thereof.
Paying Agent/Registrar/Registrar:	The paying agent ("Paying Agent/Registrar/Registrar") for the Obligations is BOKF, NA dba Bank of Texas, Austin, Texas.
Book-Entry-Only System	Upon initial issuance, the ownership of the Obligations will be registered in the registration books of Tarrant Regional Water District (the "Issuer") kept by the Paying Agent/Registrar, in the name of Cede & Co., as nominee of The Depository Trust Company, New York, New York ("DTC") to which principal, redemption premium, if any, and interest payments on the Obligations will be made. The purchasers of the Obligations will not receive physical delivery of bond certificates. Principal of, interest, and premium if any, on the Obligations will be payable at the designated office of the Paying Agent/Registrar in Austin, Texas as the same become due and payable.
Issuer:	Tarrant Regional Water District, a Water Control and Improvement District, created and functioning under Article 16, Section 59, of the Texas Constitution, pursuant to the general laws of the State of Texas, including Chapters 49 and 51, Texas Water Code, and pursuant to the provisions of Chapter 268, Acts of 1957, 55th Legislature of Texas, Regular Session, as amended (collectively, the "District Act").
Official Action:	Resolution Authorizing the Issuance, Sale and Delivery of Tarrant Regional Water District, a Water Control and Improvement District, Water Transmission Facilities Contract Revenue Bonds (City of Dallas Project), Series 2015, dated _____, 2015.
Purpose:	The Obligations are being issued for the purpose of (i) pay for design, acquisition, and construction costs related to the Dallas Project Component (as defined in the Contract) of the Project, (ii) fund a reserve fund for the Series 2015 Bonds, and (iii) pay costs of issuance of the Series 2015 Bonds.
Security for the Obligations:	See "SECTION___ PLEDGE" OF "APPENDIX B – FORM OF OFFICIAL ACTION."
Ratings:	See "OTHER INFORMATION - Ratings"
Delivery Date:	_____, 2015.

See "APPENDIX A - MATURITY SCHEDULE" for Principal Amounts,

Maturities, Interest Rates, Prices or Yields, and Initial CUSIP Numbers

TARRANT REGIONAL WATER DISTRICT
A WATER CONTROL AND IMPROVEMENT DISTRICT

BOARD OF DIRECTORS

Victor W. Henderson ..... President

Jack R. Stevens ..... Vice President

Martha V. Leonard ..... Secretary

James W. Lane. ..... Secretary Pro Tem

Mary Kelleher ..... Director

MANAGEMENT OFFICERS

James M. Oliver ..... General Manager

Alan Thomas ..... Deputy General Manager

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McCall, Parkhurst & Horton L.L.P., Co-Bond Counsel
Newby Davis PLLC, Co-Bond Counsel

First Southwest Company, LLC, Co-Financial Advisor
Kipling Jones & Co., Co- Financial Advisor

BOKF, NA dba Bank of Texas, Paying Agent/Registrar

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relating to

$140,000,000

TARRANT REGIONAL WATER DISTRICT, A WATER CONTROL AND IMPROVEMENT DISTRICT, WATER TRANSMISSION FACILITIES CONTRACT REVENUE BONDS (CITY OF DALLAS PROJECT), SERIES 2015

INTRODUCTION

This Private Placement Memorandum, including the cover page and appendices, contains brief descriptions of the Issuer, provides certain information with respect to the issuance by the Issuer, and summaries of certain provisions of the "Obligations" pursuant to the Official Action. Except as otherwise set forth herein, capitalized terms used but not defined in this Private Placement Memorandum have the meanings assigned to them in the Official Action. See "APPENDIX B – "FORM OF OFFICIAL ACTION" attached hereto.

APPENDIX A contains the maturity schedule for the Obligations. APPENDIX B contains the Official Action and a description of the purpose for the proceeds of the Obligations. APPENDIX C contains a copy of the proposed opinion of Bond Counsel with respect to the Obligations. The summaries of the documents contained in the forepart of this Private Placement Memorandum are not complete or definitive, and every statement made in this Private Placement Memorandum concerning any provision of any document is qualified by reference to such document in its entirety.

THE OBLIGATIONS

General Description

The Obligations are being issued in the aggregate principal amount set forth in APPENDIX A of this Private Placement Memorandum and will mature and be subject to redemption prior to maturity as described therein. The Obligations are being issued as fully registered bonds in denominations of $5,000**,** or any integral multiple thereof. The Obligations will be dated as of the stated date of issue and will mature on the dates referenced thereon, and will bear interest at the rates per annum set forth in "APPENDIX A - MATURITY SCHEDULE."

Interest on the Obligations is payable semiannually on each Interest Payment Date, and will be calculated on the basis of a 360-day year consisting of twelve 30-day months. Principal of and the redemption price with respect to the Obligations will be payable to the Owners upon presentation and surrender at the principal office of the Paying Agent/Registrar.

Purpose

See "APPENDIX B - FORM OF OFFICIAL ACTION."

Authority for Issuance

The Obligations are issued pursuant to the general laws of the State of Texas, including Chapters 49 and 51, Texas Water Code, as amended, and pursuant to the District Act and pursuant to the Official Action.

Security for the Obligations

See "APPENDIX B - FORM OF OFFICIAL ACTION."

Redemption Provisions

On September 1, 2026, or on any date thereafter, the Obligations maturing on and after March 1, 2026 may be redeemed prior to their scheduled maturities, upon the written direction of the Issuer, with funds provided by the Issuer, at par plus accrued interest to the date fixed for redemption as a whole, or in part, and if less than all of a maturity is to be redeemed the Paying Agent/Registrar will determine by lot the Obligations, or portions thereof within such maturity to be redeemed (provided that a portion of a Bond may be redeemed only in Authorized Denominations).

Notice of Redemption; Selection of Obligations to Be Redeemed

See "APPENDIX B - FORM OF OFFICIAL ACTION."

The Paying Agent/Registrar, so long as a Book-Entry-Only System is used for the Bonds, will send any notice of redemption of the Bonds, notice of any proposed amendment to the Official Action or other notices with respect to the Bonds only to DTC. Any failure by DTC to advise any DTC Participant (defined below), or of any DTC participant to notify the beneficial owner, shall not affect the validity of the redemption of the Bonds called for redemption or any other action premised on any such notice. Redemption of portions of the Bonds by the Issuer will reduce the outstanding principal amount of such Bonds held by DTC.

Book-Entry-Only System

The information in this caption concerning The Depository Trust Company, New York, New York ("DTC") and DTC's book entry system has been obtained from DTC and the Issuer makes no representation or warranty nor takes any responsibility for the accuracy or completeness of such information.

DTC will act as securities depository for the Obligations. The Obligations will be issued as fully-registered securities registered in the name of Cede & Co. (DTC's partnership nominee) or such other name as may be requested by an authorized representative of DTC. One fully-registered certificate will be issued for each maturity of the Obligations and deposited with DTC. See APPENDIX B - "FORM OF OFFICIAL ACTION."

DTC is a limited-purpose trust company organized under the New York Banking Law, a "banking organization" within the meaning of the New York Banking Law, a member of the Federal Reserve System, a "clearing corporation" within the meaning of the New York Uniform Commercial Code, and a "clearing agency" registered pursuant to the provisions of Section 17A of the Securities Exchange Act of 1934. DTC holds and provides asset servicing for over 3.5 million issues of U.S. and non-U.S. equity, corporate and municipal debt issues, and money market instrument (from over 100 countries) that DTC's participants (the "Direct Participants") deposit with DTC. DTC also facilitates the post-trade settlement among Direct Participants of sales and other securities transactions, in deposited securities, through electronic computerized book entry transfers and pledges between Direct Participants' accounts. This eliminates the need for physical movement of securities certificates. Direct Participants include both U.S. and non-U.S. securities brokers and dealers, banks, trust companies, clearing corporations, and certain other organizations. DTC is a wholly-owned subsidiary of The Depository Trust & Clearing Corporation ("DTCC"). DTCC is the holding company for DTC, National Securities Clearance Corporation, and Fixed Income Clearance Corporation, all of which are registered clearing agencies. DTCC is owned by the users of its regulated subsidiaries. Access to the DTC system is also available to others such as both U.S. and non-U.S. securities brokers and dealers, banks, trust companies, and clearing corporations that clear through or maintain a custodial relationship with a Direct Participant, either directly or indirectly ("Indirect Participants"). Direct Participants and Indirect Participants are referred to herein collectively as "Participants". DTC has a Standard & Poor's rating of "AA+". The DTC Rules applicable to its Participants are on file with the Securities and Exchange Commission. More information about DTC can be found at www.dtcc.com and www.dtc.org.

Purchases of Obligations under the DTC system must be made by or through Direct Participants, which will receive a credit for the Obligations on DTC's records. The ownership interest of each actual purchaser of each Bond ("Beneficial Owner") is in turn to be recorded on the Participants' records. Beneficial Owners will not receive written confirmation from DTC of their purchase. Beneficial Owners are, however, expected to receive written confirmations providing details of the transaction, as well as periodic statements of their holdings, from the Participant through which the Beneficial Owner entered into the transaction.

Transfers of ownership interests in the Obligations are to be accomplished by entries made on the books of Participants acting on behalf of Beneficial Owners. Beneficial Owners will not receive Obligations representing their ownership interests in Obligations, except in the event that use of the book-entry system for the Obligations is discontinued.

To facilitate subsequent transfers, all Obligations deposited by Direct Participants with DTC are registered in the name of DTC's partnership nominee, Cede & Co., or such other name as may be requested by an authorized representative of DTC. The deposit of Obligations with DTC and their registration in the name of Cede & Co. or such other DTC nominee do not effect any change in beneficial ownership. DTC has no knowledge of the actual Beneficial Owners of the Obligations; DTC's records reflect only the identity of the Direct Participants to whose

accounts such Obligations are credited, which may or may not be the Beneficial Owners. The Participants will remain responsible for keeping account of their holdings on behalf of their customers.

Conveyance of notices and other communications by DTC to Direct Participants, by Direct Participants to Indirect Participants, and by Direct Participants and Indirect Participants to Beneficial Owners will be governed by arrangements among them, subject to any statutory or regulatory requirements as may be in effect from time to time.

Redemption notices shall be sent to DTC. If less than all of the Obligations within a maturity are being redeemed, DTC's practice is to determine by lot the amount of the interest of each Direct Participant in such maturity to be redeemed.

Neither DTC nor Cede & Co. (nor any other DTC nominee) will consent or vote with respect to Obligations unless authorized by a Direct Participant in accordance with DTC's Money Market Instrument Procedures. Under its usual procedures, DTC mails an Omnibus Proxy to the Issuer as soon as possible after the record date. The Omnibus Proxy assigns Cede & Co.'s consenting or voting rights to those Direct Participants to whose accounts Obligations are credited on the record date (identified in a listing attached to the Omnibus Proxy).

All payments on the Obligations will be made to Cede & Co., or such other nominee as may be requested by an authorized representative of DTC. DTC's practice is to credit Direct Participants' accounts upon DTC's receipt of funds and corresponding detail information from the Issuer or the Paying Agent/Registrar, on payable date in accordance with their respective holdings shown on DTC's records. Payments by Participants to Beneficial Owners will be governed by standing instructions and customary practices, as is the case with Obligations held for the accounts of customers in bearer form or registered in "street name," and will be the responsibility of such Participant and not of DTC, the Paying Agent/Registrar, or the Issuer, subject to any statutory or regulatory requirements as may be in effect from time to time. All payments to Cede & Co. (or such other nominee as may be requested by an authorized representative of DTC) are the responsibility of the Issuer or the Paying Agent/Registrar, disbursement of such payments to Direct Participants will be the responsibility of DTC, and disbursement of such payments to the Beneficial Owners will be the responsibility of Participants.

DTC may discontinue providing its services as depository with respect to the Obligations at any time by giving reasonable notice to the Issuer or the Paying Agent/Registrar. Under such circumstances, in the event that a successor depository is not obtained, Obligations are required to be printed and delivered.

With the consent of the Texas Water Development Board, the Issuer may decide to discontinue use of the system of book-entry-only transfers through DTC (or a successor securities depository). In that event, Obligations will be printed and delivered to DTC or successor securities depository.

TAX MATTERS

Opinion

Bond Counsel will deliver its opinion on the date of delivery of the Obligations substantially in the form as attached in "APPENDIX C - FORM OF OPINION OF BOND COUNSEL."

OTHER INFORMATION

Forward Looking Statements

The statements contained in this Private Placement Memorandum, including the cover page, appendices, and any other information or documents provided by the Issuer, that are not purely historical, are forward-looking statements, including statements regarding the Issuer's assumptions, expectations, hopes, intentions, or strategies regarding the future. Any of such assumptions, expectations or hopes could be inaccurate and, therefore, there can be no assurance that the forward-looking statements included herein will prove to be accurate. Holders of the Bonds should not place undue reliance on forward-looking statements. All forward-looking statements included in this Private Placement Memorandum are based on information available to the Issuer on the date hereof, and the Issuer assumes no obligation to update any such forward-looking statements. It is important to note that the Issuer's actual results could differ materially from those in such forward-looking statements.

Ratings

The existing outstanding City of Dallas (the "City") contract revenue bonds are rated "AAA" by Standard & Poor's Ratings Services, a Standard & Poor's Financial Services LLC business, and "Aa1" by Moody's Investors Service, Inc. An explanation of the significance of such ratings may be obtained from the company furnishing the rating. The ratings reflect only the respective views of such rating companies, and the District makes no representation as to the appropriateness of the ratings. There is no assurance that such ratings will continue for any given period of time, or that they will not be revised downward or withdrawn entirely by either or both of such rating companies, if in the judgment of either or both companies, circumstances so warrant. Any such downward revision or withdrawal of such ratings, by either of them, may have an adverse effect on the market price of the Obligations. **No application has been made to any rating agency or municipal bond insurance company for qualification of the Obligations for ratings or municipal bond insurance, respectively.**

LITIGATION

There is no litigation, proceeding, inquiry, or investigation pending by or before any court or other governmental authority or entity (or, to the best knowledge of the Issuer, threatened) that adversely affects the power, authority or obligation of the Issuer to deliver the Bonds, the security for, or the validity of, the Bonds or the financial condition of the Issuer. On the date of initial delivery of Bonds, the Issuer will execute and deliver a certificate of like effect to the purchaser of the Bonds.

CONTINUING DISCLOSURE OF INFORMATION

In the Official Action, the Issuer has made the following agreement for the benefit of the holders and beneficial owners of the Obligations. The City is required to observe the agreement for so long as it remains obligated to advance funds to pay the Obligations. Under the agreement, the Issuer will be obligated to provide certain updated financial information and operating data, and timely notice of specified material events, to certain other information vendors. SEE APPENDIX B - "FORM OF OFFICIAL ACTION."

Compliance with Prior Undertakings

During the last five years, the City believes it has complied in all material respects with all continuing disclosure agreements made by it in accordance with the Rule. During the time when the City was unable to timely prepare its audited financial statements, in order to comply with the Rule, the City filed unaudited financial information for the fiscal years in question, and promptly filed audited financial statements once available.

MISCELLANEOUS

Any statements made in this Private Placement Memorandum involving matters of opinion or of estimates, whether or not so expressly stated, are set forth as such and not as representations of fact, and no representation is made that any of the estimates will be realized. Neither this Private Placement Memorandum nor any statement that may have been made verbally or in writing is to be construed as a contract with the owners of the Obligations.

The information contained above is neither guaranteed as to accuracy or completeness nor to be construed as a representation by the Issuer. The information and expressions of opinion herein are subject to change without notice and neither the delivery of this Private Placement Memorandum nor any sale made hereunder is to create, under any circumstances, any implication that there has been no change in the affairs of the Issuer or the Issuer from the date hereof.

The Private Placement Memorandum is submitted in connection with the sale of the securities referred to herein and may not be reproduced or used, as a whole or in part, for any other purpose.

ADDITIONAL INFORMATION

The Private Placement Memorandum speaks only as of its date and the information contained herein is subject to change. Descriptions of the Obligations and the Official Action and any other agreements and documents contained herein constitute summaries of certain provisions thereof and do not purport to be complete.

APPENDIX A

MATURITY SCHEDULE **CUSIP Prefix: 876448** [(1)]
(Due September 1)

Amount	Maturity September 1,	Rate	Yield	CUSIP Suffix	Amount	Maturity September 1,	Rate	Yield	CUSIP Suffix
$3,360,000	2017				$4,695,000	2032			
3,395,000	2018				4,845,000	2033			
3,440,000	2019				5,005,000	2034			
3,495,000	2020				5,170,000	2035			
3,550,000	2021				5,345,000	2036			
3,620,000	2022				5,530,000	2037			
3,690,000	2023				5,725,000	2038			
3,770,000	2024				5,925,000	2039			
3,855,000	2025				6,130,000	2040			
3,950,000	2026				6,340,000	2041			
4,050,000	2027				6,570,000	2042			
4,165,000	2028				6,800,000	2043			
4,285,000	2029				7,040,000	2044			
4,415,000	2030				7,290,000	2045			
4,550,000	2031								

(1) CUSIP is a registered trademark of the American Bankers Association. CUSIP data is provided by CUSIP Global Services, managed by Standard & Poor's Financial Services LLC on behalf of the American Bankers Association. This data is not intended to create a database and does not serve in any way as a substitute for the CUSIP services. Neither the Issuer nor the Co-Financial Advisors take any responsibility for the accuracy of CUSIP numbers.

APPENDIX B

FORM OF OFFICIAL ACTION

APPENDIX C

FORM OF OPINION OF BOND COUNSEL

LAW OFFICES
McCALL, PARKHURST & HORTON L.L.P.

600 CONGRESS AVENUE
SUITE 1800
AUSTIN, TEXAS 78701-3248
TELEPHONE: 512 478-3805
FACSIMILE: 512 472-0871

717 NORTH HARWOOD
SUITE 900
DALLAS, TEXAS 75201-6587
TELEPHONE: 214 754-9200
FACSIMILE: 214 754-9250

700 N. ST. MARY'S STREET
SUITE 1525
SAN ANTONIO, TEXAS 78205-3503
TELEPHONE: 210 225-2800
FACSIMILE: 210 225-2984

December 20, 2011

Board of Directors
Tarrant Regional Water District,
a Water Control and Improvement District
800 East North Side Drive
Fort Worth, Texas 76102

Ladies and Gentlemen:

You have requested that we act as bond counsel ("Bond Counsel") for Tarrant Regional Water District, a Water Control and Improvement District ("TRWD") in connection with the issuance of bonds, notes, or other obligations, including those issued for refunding purposes and those issued pursuant to contracts with third parties (collectively, the "Bonds"), of TRWD. The purpose of this letter is to set forth mutually agreeable terms for our engagement.

Generally, we will perform all usual and necessary legal services as Bond Counsel in connection with the authorization, issuance and delivery of the Bonds. Specifically, we will prepare and direct the legal proceedings and perform the other necessary legal services with reference to the authorization, issuance and delivery of the Bonds, including the following:

a. Prepare all resolutions and other instruments, including contracts for contract revenue bonds, pursuant to which the Bonds will be authorized, issued, delivered and secured, in cooperation and upon consultation with the Board of Directors of TRWD, its General Manager and staff, TRWD's legal counsel and the financial advisors and/or the underwriters and their legal counsel, and any other advisors and consultants of TRWD.

b. Review and consult with respect to contracts which are to provide specifically the source of revenues for the payment and security of any Bonds.

c. Review and consult with respect to all other matters and transactions that bear on the security of the Bonds.

d. With reference to the preparations for and authorization and issuance of the Bonds, attend meetings to the extent required or requested.

FINANCIAL ADVISORY AGREEMENT

This Financial Advisory Agreement (the "Agreement") is made and entered into by and between Tarrant Regional Water District, A Water Control and Improvement District ("Issuer") and First Southwest Company ("FSC") effective as of the date executed by the Issuer as reflected on the signature page hereof.

WITNESSETH:

WHEREAS, the Issuer will have under consideration from time to time the authorization and issuance of indebtedness in amounts and forms which cannot presently be determined and, in connection with the authorization, sale, issuance and delivery of such indebtedness, Issuer desires to retain an independent financial advisor; and

WHEREAS, the Issuer desires to obtain the professional services of FSC to advise the Issuer regarding the issuance and sale of certain evidences of indebtedness or debt obligations that may be authorized and issued or otherwise created or assumed by the Issuer (hereinafter referred to collectively as the "Debt Instruments") from time to time during the period in which this Agreement shall be effective; and

WHEREAS, FSC is willing to provide its professional services and its facilities as financial advisor in connection with all programs of financing as may be considered and authorized by Issuer during the period in which this Agreement shall be effective.

NOW, THEREFORE, the Issuer and FSC, in consideration of the mutual covenants and agreements herein contained and other good and valuable consideration, do hereby agree as follows:

SECTION I
DESCRIPTION OF SERVICES

Upon the request of an authorized representative of the Issuer, FSC agrees to perform the financial advisory services stated in the following provisions of this Section I; and for having rendered such services, the Issuer agrees to pay to FSC the compensation as provided in Section V hereof.

A. Financial Planning. At the direction of Issuer, FSC shall:

1. Survey and Analysis. Conduct a survey of the financial resources of the Issuer to determine the extent of its capacity to authorize, issue and service any Debt Instruments contemplated.

1. Method of Sale. Evaluate the particular financing being contemplated, giving consideration to the complexity, market acceptance, rating, size and structure in order to make a recommendation as to an appropriate method of sale, and:

a. If the Debt Instruments are to be sold by an advertised competitive sale, FSC will:

(1) Supervise the sale of the Debt Instruments, reserving the right, alone or in conjunction with others, to submit a bid for any Debt Instruments issued under this Agreement which the Issuer advertises for competitive bids; however, in keeping with the provisions of Rule G-23 of the Municipal Securities Rulemaking Board, FSC will request and obtain written consent to bid prior to submitting a bid, in any instance wherein FSC elects to bid, for any installment of such Debt Instruments;

(2) Disseminate information to prospective bidders, organize such informational meetings as may be necessary, and facilitate prospective bidders' efforts in making timely submission of proper bids;

(3) Assist the staff of the Issuer in coordinating the receipt of bids, the safekeeping of good faith checks and the tabulation and comparison of submitted bids; and

(4) Advise the Issuer regarding the best bid and provide advice regarding acceptance or rejection of the bids.

b. If the Debt Instruments are to be sold by negotiated sale, FSC will:

(1) Recommend for Issuer's final approval and acceptance one or more investment banking firms as managers of an underwriting syndicate for the purpose of negotiating the purchase of the Debt Instruments.

(2) Cooperate with and assist any selected managing underwriter and their counsel in connection with their efforts to prepare any Official Statement or Offering Memorandum. FSC will cooperate with and assist the underwriters in the preparation of a bond purchase contract, an underwriters agreement and other related documents. The costs incurred in such efforts, including the printing of the documents, will be paid in accordance with the terms of the Issuer's agreement with the underwriters, but shall not be or become an obligation of FSC, except to the extent specifically

provided otherwise in this Agreement or assumed in writing by FSC.

(3) Assist the staff of the Issuer in the safekeeping of any good faith checks, to the extent there are any such, and provide a cost comparison, for both expenses and interest which are suggested by the underwriters, to the then current market.

(4) Advise the Issuer as to the fairness of the price offered by the underwriters.

2. Offering Documents. Coordinate the preparation of the notice of sale and bidding instructions, official statement, official bid form and such other documents as may be required and submit all such documents to the Issuer for examination, approval and certification. After such examination, approval and certification, FSC shall provide the Issuer with a supply of all such documents sufficient to its needs and distribute by mail sets of the same to prospective purchasers of the Debt Instruments. Also, FSC shall provide copies of the final Official Statement to the purchaser of the Debt Instruments in accordance with the Notice of Sale and Bidding Instructions.

3. Credit Ratings. Make recommendations to the Issuer as to the advisability of obtaining a credit rating, or ratings, for the Debt Instruments and, when directed by the Issuer, coordinate the preparation of such information as may be appropriate for submission to the rating agency, or agencies. In those cases where the advisability of personal presentation of information to the rating agency, or agencies, may be indicated, FSC will arrange for such personal presentations, utilizing such composition of representatives from the Issuer as may be finally approved or directed by the Issuer.

4. Trustee, Paying Agent, Registrar. Upon request, counsel with the Issuer in the selection of a Trustee and/or Paying Agent/Registrar for the Debt Instruments, and assist in the negotiation of agreements pertinent to these services and the fees incident thereto.

5. Financial Publications. When appropriate, advise financial publications of the forthcoming sale of the Debt Instruments and provide them with all pertinent information.

6. Consultants. After consulting with and receiving directions from the Issuer, arrange for such reports and opinions of recognized independent consultants as may be appropriate for the successful marketing of the Debt Instruments.

7. Auditors. In the event formal verification by an independent auditor of any calculations incident to the Debt Instruments is required, make arrangements for such services.

8. Issuer Meetings. Attend meetings of the governing body of the Issuer, its staff, representatives or committees as requested at all times when FSC may be of assistance or service and the subject of financing is to be discussed.

9. Printing. To the extent authorized by the Issuer, coordinate all work incident to printing of the offering documents and the Debt Instruments.

10. Bond Counsel. Maintain liaison with Bond Counsel in the preparation of all legal documents pertaining to the authorization, sale and issuance of the Debt Instruments.

11. Changes in Laws. Provide to the Issuer copies of proposed or enacted changes in federal and state laws, rules and regulations having, or expected to have, a significant effect on the municipal bond market of which FSC becomes aware in the ordinary course of its business, it being understood that FSC does not and may not act as an attorney for, or provide legal advice or services to, the Issuer.

12. Delivery of Debt Instruments. As soon as a bid for the Debt Instruments is accepted by the Issuer, coordinate the efforts of all concerned to the end that the Debt Instruments may be delivered and paid for as expeditiously as possible and assist the Issuer in the preparation or verification of final closing figures incident to the delivery of the Debt Instruments.

13. Debt Service Schedule; Authorizing Resolution. After the closing of the sale and delivery of the Debt Instruments, deliver to the Issuer a schedule of annual debt service requirements for the Debt Instruments and, in coordination with Bond Counsel, assure that the paying agent/registrar and/or trustee has been provided with a copy of the authorizing ordinance, order or resolution.

SECTION II
OTHER AVAILABLE SERVICES

In addition to the services set forth and described in Section I hereinabove, FSC agrees to make available to Issuer the following services, when so requested by the Issuer and subject to the agreement by Issuer and FSC regarding the compensation, if any, to be paid for such services, it being understood and

agreed that the services set forth in this Section II shall require further agreement as to the compensation to be received by FSC for such services:

1. Investment of Funds. From time to time, as an incident to the other services provided hereunder as financial advisor, FSC may purchase such investments as may be directed and authorized by Issuer to be purchased, it being understood that FSC will be compensated in the normal and customary manner for each such transaction. In any instance wherein FSC may become entitled to receive fees or other compensation in any form from a third party with respect to these investment activities on behalf of Issuer, FSC will disclose to Issuer the nature and, to the extent such is known, the amount of any such compensation so that Issuer may consider the information in making its investment decision. It is understood and agreed that FSC is a duly licensed broker/dealer and is affiliated with First Southwest Asset Management, Inc. ("FSAMI"), a duly registered investment advisor. Issuer may, from time to time, utilize the broker/dealer and/or investment advisory services of FSC and/or FSAMI with respect to matters which do not involve or affect the investment of bond proceeds or the financial advisory services referenced in this Agreement. The terms and conditions of the engagement of FSC and/or FSAMI to provide such services shall not be affected by the terms of this Agreement.

2. Exercising Calls and Refunding. Provide advice and assistance with regard to exercising any call and/or refunding of any outstanding Debt Instruments.

3. Capital Improvements Programs. Provide advice and assistance in the development of any capital improvements programs of the Issuer.

4. Long-Range Planning. Provide advice and assistance in the development of other long-range financing plans of the Issuer.

5. Post-Sale Services. Subsequent to the sale and delivery of Debt Instruments, review the transaction and transaction documentation with legal counsel for the Issuer, Bond Counsel, auditors and other experts and consultants retained by the Issuer and assist in developing appropriate responses to legal processes, audit procedures, inquiries, intemal reviews and similar matters.

SECTION III
TERM OF AGREEMENT

This Agreement shall become effective as of the date executed by Issuer as reflected on the signature page hereof and, unless terminated by either party pursuant to Section IV of this Agreement, shall remain

in effect thereafter for a period of five (5) years from such date. Unless FSC or Issuer shall notify the other party in writing at least thirty (30) days in advance of the applicable anniversary date that this Agreement will not be renewed, this Agreement will be automatically renewed on the fifth anniversary of the date hereof for an additional one (1) year period and thereafter will be automatically renewed on each anniversary date for successive one (1) year periods.

SECTION IV
TERMINATION

This Agreement may be terminated with or without cause by the Issuer or FSC upon the giving of at least thirty (30) days' prior written notice to the other party of its intention to terminate, specifying in such notice the effective date of sucb termination. In the event of such termination, it is understood and agreed that only the amounts due FSC for services provided and expenses incurred to the date of termination will be due and payable. No penalty will be assessed for termination of this Agreement.

SECTION V
COMPENSATION AND EXPENSE REIMBURSEMENT

The fees due to FSC for the services set forth and described in Section I of this Agreement with respect to each issuance of Debt Instruments during the term of this Agreement shall be calculated in accordance with the schedule set forth on Appendix A attached hereto. Unless specifically provided otherwise on Appendix A or in a separate written agreement between Issuer and FSC, such fees, together with any other fees as may have been mutually agreed upon and all expenses for which FSC is entitled to reimbursement, shall become due and payable concurrently with the delivery of the Debt Instruments to the purchaser.

SECTION VI
MISCELLANEOUS

1. Choice of Law. This Agreement shall be construed and given effect in accordance with the laws of the State of Texas.

2. Binding Effect; Assignment. This Agreement shall be binding upon and inure to the benefit of the Issuer and FSC, their respective successors and assigns; provided however, neither party hereto may assign or transfer any of its rights or obligations hereunder without the prior written consent of the other party.

3. Entire Agreement. This instrument contains the entire agreement between the parties relating to the rights herein granted and obligations herein assumed. Any oral or written representations or modifications concerning this Agreement shall be of no force or effect except for a subsequent modification in writing signed by all parties hereto.

FIRST SOUTHWEST COMPANY

By: _____
Hill A. Feinberg, Chairman and
Chief Executive Officer

By: _____
David K. Medanich
Senior Vice President

TARRANT REGIONAL WATER DISTRICT

By: _____
Title: General Manager
Date: 5/13/99

ATTEST:

_____
Secretary

APPENDIX A

The fees due FSC will not exceed those contained in our customary fee schedule as listed below.

$10.00 per $1,000 ($7,500 Minimum)			for the first	$	750,000	of bonds issued
plus	$ 7.50	per $1,000	for the next	$	750,000	of bonds issued
plus	$ 5.00	per $1,000	for the next	$	3,500,000	of bonds issued
plus	$ 3.00	per $1,000	for the next	$	5,000,000	of bonds issued
plus	$ 2.00	per $1,000	for the next	$	10,000,000	of bonds issued
plus	$ 1.50	per $1,000	over the next	$	20,000,000	and thereafter

The above charges shall be multiplied by 1.25 times for the completion of an application to a federal or state government agency or for the issuance of revenue bonds or refunding bonds, reflecting the additional services required.

The charges for ancillary services, including computer structuring and official statement printing, shall be levied only for those services which are reasonably necessary in completing the transaction and which are reasonable in amount, unless such charges were incurred at the specific direction of the Issuer.

The payment of charges for financial advisory services described in Section I of the foregoing Agreement shall be contingent upon the delivery of bonds and shall be due at the time that bonds are delivered. The payment of charges for services described in Section II of the foregoing Agreement shall be due and payable in accordance with the mutual agreement therefor between FSC and Issuer.

The Issuer shall be responsible for the following expenses, if and when applicable, whether they are charged to the Issuer directly as expenses or charged to the Issuer by FSC as reimbursable expenses:

Bond counsel
Bond printing
Bond ratings
Computer structuring
Credit enhancement
CPA fees for refunding
Official statement preparation and printing
Paying agent/registrar/trustee
Travel expenses
Underwriter and underwriters counsel
Miscellaneous, including copy, delivery, and phone charges

The payment of reimbursable expenses that FSC has assumed on behalf of the Issuer shall NOT be contingent upon the delivery of bonds and shall be due at the time that services are rendered and payable upon receipt of an invoice therefor submitted by FSC.

Part B #17

TWDB-0201a
Rev 1/3/2014

Application Filing and Authorized Representative Resolution (WRD-201a)

A RESOLUTION by the Board of Directors of the Tarrant Regional Water District requesting financial assistance from the Texas Water Development Board; authorizing the filing of an application for assistance; and making certain findings in connection therewith.

BE IT RESOLVED BY THE Board of Directors OF THE Tarrant Regional Water District:

SECTION 1: That an application is hereby approved and authorized to be filed with the Texas Water Development Board seeking financial assistance in an amount not to exceed $440,000,000 to provide for the costs of Integrated Pipeline Project (Tarrant Regional Water District - $300,000,000 and City of Dallas IPL Project - $140,000,000)

SECTION 2: That Board President, General Manager or Director of Finance be and is hereby designated the authorized representative of the Tarrant Regional Water District for purposes of furnishing such information and executing such documents as may be required in connection with the preparation and filing of such application for financial assistance and the rules of the Texas Water Development Board.

SECTION 3: That the following firms and individuals are hereby authorized and directed to aid and assist in the preparation and submission of such application and appear on behalf of and represent the Tarrant Regional Water District before any hearing held by the Texas Water Development Board on such application, to wit:

Financial Advisor: David Medanich or Laura Alexander
First Southwest Company
Fort Worth Texas

Engineer: _____

Bond Counsel: Alan Raynor
McCall, Parkhurst & Horton L.L.P.
Dallas Texas

PASSED AND APPROVED, this the 19 day of May, 2015.

ATTEST: Martha V. Leonard

By: Victor W. Henderson

(Seal)

Part B #18

TWDB-0201
Revised 2/21/2013

Application Affidavit (WRD-201)

THE STATE OF TEXAS §
COUNTY OF Tarrant §
APPLICANT Tarrant Regional Water District §

BEFORE ME, the undersigned, a Notary Public in and for the State of Texas, on this day personally appeared _____ as the Authorized Representative of the Tarrant Regional Water District, who being by me duly sworn, upon oath says that:

1. the decision by the Tarrant Regional Water District (authority, city, county, corporation, district) to request financial assistance from the Texas Water Development Board ("Board") was made in a public meeting held in accordance with the Open Meetings Act (Government Code, §551.001, et seq,) and after providing all such notice as required by such Act as is applicable to the Tarrant Regional Water District (authority, city, county, corporation, district) ;

2. the information submitted in the application is true and correct according to my best knowledge and belief;

3. the Tarrant Regional Water District (authority, city, county, corporation, district) has no pending, threatened, or outstanding judgments, orders, fines, penalties, taxes, assessment or other enforcement or compliance issue of any kind or nature by the Environmental Protection Agency, Texas Commission on Environmental Quality, Texas Comptroller, Texas Secretary of State, or any other federal, state or local government, except for the following (if no such outstanding compliance issues, write in "none"):

none.

4. the Tarrant Regional Water District (authority, city, county, corporation, district) warrants compliance with the representations made in the application in the event that the Board provides the financial assistance; and

5. the Tarrant Regional Water District (authority, city, county, corporation, district) will comply with all applicable federal laws, rules, and regulations as well as the laws of this state and the rules and regulations of the Board.

Victor W. Henderson
Official Representative

Title: President

SWORN TO AND SUBSCRIBED BEFORE ME, by Victor W. Henderson,
this 19th day of May, 2015.

(NOTARY SEAL) NANCY L. KING NOTARY PUBLIC STATE OF TEXAS 05-14-2016

Nancy L. King
Notary Public, State of Texas

Part B # 19

TWDB—0201B
Revised 02/21/2013

Application Resolution - Certificate of Secretary (WRD-201b)

THE STATE OF TEXAS §
COUNTY OF Tarrant §
APPLICANT Tarrant Regional Water District §

I, the undersigned, Secretary of the Tarrant Regional Water District Texas, DO HEREBY CERTIFY as follows:

1. That on the 19 day of May, 20 15, a regular/special meeting of the Tarrant Regional Water District was held at a meeting place within the City; the duly constituted members of the Board of Directors being as follows:

Victor Henderson, Jack Stevens, Martha Leonard, James Lane and Mary Kelleher

and all of said persons were present at said meeting, except the following:

none

Among other business considered at said meeting, the attached resolution entitled:

"A RESOLUTION by the Board of Directors of the Tarrant Regional Water District requesting financial participation from the Texas Water Development Board; authorizing the filing of an application for financial participation; and making certain findings in connection therewith."

was introduced and submitted to the Board of Directors for passage and adoption. After presentation and due consideration of the resolution, and upon a motion made by Jim Lane and seconded by Marty Leonard, the resolution was duly passed and adopted by the TRWD Board by the following vote:

5 voted "For" 0 voted "Against" 0 abstained

all as shown in the official Minutes of the Tarrant Regional Water District for the meeting held on the aforesaid date.

2. That the attached resolution is a true and correct copy of the original on file in the official records of the Tarrant Regional Water District; the duly qualified and acting members of the Board of Directors on the date of the aforesaid meeting are those persons shown above and, according to the records of my office, advance notice of the time, place and purpose of said meeting was given to each member of the Board of Directors; and that said meeting, and deliberation of the aforesaid public business, was open to the public and written notice of said meeting, including the subject of the above entitled resolution, was posted and given in advance thereof in compliance with the provisions of Chapter 551 of the Texas Government Code.

IN WITNESS WHEREOF, I have hereunto signed my name officially and affixed the seal of said Tarrant Regional Water District this the 19 of May, 20 15.

(SEAL)

Martha V. Leonard
Secretary

Part B # 21

2014

CERTIFICATE FOR RESOLUTION

THE STATE OF TEXAS :
COUNTY OF TARRANT :
TARRANT REGIONAL WATER DISTRICT,
A WATER CONTROL AND IMPROVEMENT DISTRICT :

We, the undersigned officers of the Board of Directors of said District, hereby certify as follows:

1. The Board of Directors of said District convened in REGULAR MEETING ON THE 21ST OF JANUARY, 2014, at the regular designated meeting place, and the roll was called of the duly constituted officers and members of said Board, to-wit:

Victor W. Henderson, President
Jack R. Stevens, Vice President
Martha V. Leonard, Secretary
James W. Lane, Secretary Pro Tem
Mary Kelleher, Director

and all of said persons were present, except the following absentees: none, thus constituting a quorum. Whereupon, among other business the following was transacted at said Meeting: a written

RESOLUTION AUTHORIZING THE ISSUANCE, SALE, AND DELIVERY OF TARRANT REGIONAL WATER DISTRICT, A WATER CONTROL AND IMPROVEMENT DISTRICT, WATER TRANSMISSION FACILITIES CONTRACT REVENUE BONDS (CITY OF DALLAS PROJECT), SERIES 2014, PLEDGING REVENUES FOR THE PAYMENT OF THE BONDS, APPROVING AN OFFICIAL STATEMENT, AND AUTHORIZING OTHER INSTRUMENTS AND PROCEDURES RELATING THERETO

was duly introduced for the consideration of said Board and read in full. It was then duly moved and seconded that said Resolution be passed; and, after due discussion, said motion, carrying with it the passage of said Resolution, prevailed and carried by the following vote:

AYES: All members of said Board shown present above voted "Aye"; except Kelleher.

NOES: 0.

ABSTENTION: 1

2. That a true, full, and correct copy of the aforesaid Resolution passed at the Meeting described in the above and foregoing paragraph is attached to and follows this Certificate; that said Resolution has been duly recorded in said Board's minutes of said Meeting; that the above and foregoing paragraph is a true, full, and correct excerpt from said Board's minutes of said Meeting pertaining to the passage of said Resolution; that the persons named in the above and foregoing paragraph are the duly chosen, qualified, and acting officers and members of said Board as indicated therein; that each of the officers and members of said Board was duly and sufficiently notified officially and personally, in advance, of the time, place, and purpose of the aforesaid Meeting, and that said Resolution would be introduced and considered for passage at said Meeting, and each of said officers and members consented, in advance, to the holding of said Meeting for such purpose; and that said Meeting was open to the public, and public notice of the time, place, and purpose of said Meeting was given all as required by Chapter 551, Texas Government Code.

SIGNED AND SEALED the 21st day of January, 2014.

Martha V. Lemm
Secretary, Board of Directors

Victor Henderson
President, Board of Directors

(SEAL)

RESOLUTION AUTHORIZING THE ISSUANCE, SALE, AND DELIVERY OF TARRANT REGIONAL WATER DISTRICT, A WATER CONTROL AND IMPROVEMENT DISTRICT, WATER TRANSMISSION FACILITIES CONTRACT REVENUE BONDS (CITY OF DALLAS PROJECT), SERIES 2014, PLEDGING REVENUES FOR THE PAYMENT OF THE BONDS, APPROVING AN OFFICIAL STATEMENT, AND AUTHORIZING OTHER INSTRUMENTS AND PROCEDURES RELATING THERETO

THE STATE OF TEXAS §
COUNTY OF TARRANT §
TARRANT REGIONAL WATER DISTRICT,
A WATER CONTROL AND IMPROVEMENT DISTRICT §

WHEREAS, Tarrant Regional Water District, a Water Control and Improvement District, (formerly known as "Tarrant County Water Control and Improvement District Number One") (the "Issuer" or "District") is a political subdivision of the State of Texas, being a conservation and reclamation district created and functioning under Article 16, Section 59, of the Texas Constitution, pursuant to the general laws of the State of Texas, including Chapters 49 and 51, Texas Water Code, and pursuant to the provisions of Chapter 268, Acts of 1957, 55th Legislature of Texas, Regular Session, as amended (collectively, the "District Act"); and

WHEREAS, a Water Transmission Facilities Financing Agreement, dated November 16, 2010 (the "Contract"), has been duly executed by the Issuer and the City of Dallas, Texas (the "City"), with respect to the acquisition, construction, and financing of an integrated pipeline project (as defined therein and as used herein, the "Project").

WHEREAS, the Issuer will authorize the Series 2014 Bonds (hereinafter defined) pursuant to the Contract, the District Act, Chapter 1371, Texas Government Code, as amended, and other applicable laws; and

WHEREAS, the meeting was open to the public and public notice of the time, place and purpose of said meeting was given pursuant to Chapter 551, Texas Government Code.

THEREFORE, BE IT RESOLVED BY THE BOARD OF DIRECTORS OF TARRANT REGIONAL WATER DISTRICT, A WATER CONTROL AND IMPROVEMENT DISTRICT, THAT:

Section 1. AMOUNT AND PURPOSE OF THE BONDS. The bond or bonds of the Issuer are hereby authorized to be issued and delivered, in one or more series, in an aggregate principal amount not to exceed $230,000,000, and in the manner hereinafter provided, for the purpose of obtaining funds to (i) pay for design, acquisition, and construction costs related to the Dallas Project Component (as defined in the Contract) of the Project, (ii) fund a reserve fund for the Series 2014 Bonds, and (iii) pay costs of issuance of the Series 2014 Bonds.

Section 2. DESIGNATION OF THE BONDS. Each bond issued pursuant to this Resolution shall be designated: "TARRANT REGIONAL WATER DISTRICT, A WATER CONTROL AND IMPROVEMENT DISTRICT, WATER TRANSMISSION FACILITIES CONTRACT REVENUE BOND (CITY OF DALLAS PROJECT), SERIES 2014." Initially there

shall be issued, sold, and delivered hereunder a single fully registered bond, without interest coupons, payable in installments of principal (the "Initial Bond"), but the Initial Bond may be assigned and transferred and/or converted into and exchanged for a like aggregate amount of fully registered bonds, without interest coupons, having serial maturities, and in the denomination or denominations of $5,000 or any integral multiple of $5,000, all in the manner hereinafter provided. The term "Series 2014 Bonds" as used in this Resolution shall mean and include collectively the Initial Bond and all substitute bonds exchanged therefor, as well as all other substitute bonds and replacement bonds issued pursuant hereto, and the term "Series 2014 Bond" shall mean any of the Series 2014 Bonds.

Section 3. INITIAL DATE, DENOMINATION, NUMBER, MATURITIES, INITIAL REGISTERED OWNER, AND CHARACTERISTICS OF THE INITIAL BOND. (a) As authorized by Chapter 1371, Texas Government Code, as amended, the President of the Board of Directors, the General Manager, and the Finance Director of the Issuer are each hereby designated as an "Authorized Officer" of the Issuer, and each is hereby authorized, appointed, and designated as the officer or employee of the Issuer authorized to act on behalf of the Issuer, which actions shall be evidenced by a certificate executed by such Authorized Officer (the "Approval Certificate") for a period not to extend beyond July 15, 2014, in the sale, whether by bid or negotiation, and delivery of the Series 2014 Bonds and in carrying out the other procedures specified in this Resolution, including the use of a book-entry only system with respect to the Series 2014 Bonds and the execution of an appropriate letter of representations if deemed appropriate, the determining and fixing of the date and the date of delivery of the Series 2014 Bonds, any additional or different designation or title by which the Bond shall be known, the price at which the Series 2014 Bonds will be sold (but in no event less than 97% of the principal amount of the Series 2014 Bonds), the principal amount (not exceeding $230,000,000) of the Series 2014 Bonds, the amount of each maturity of principal thereof (with annual payments of principal and interest not greater than 10% more or less in any one year, commencing with the year 2015, than any other year), the due date of each such maturity (but in no event later than September 1, 2044), the rate of interest to be bome by each such maturity (but in no event to result in the net effective interest rate on the Series 2014 Bonds exceeding 5.00%), the initial interest payment date, the date or dates of optional redemption thereof, any mandatory sinking fund redemption provisions, and approving modifications to this Resolution and executing such instruments, documents and agreements as may be necessary with respect thereto, and all other matters relating to the issuance, sale and delivery of the Series 2014 Bonds. It is further provided, however, that, notwithstanding the foregoing provisions, the Series 2014 Bonds shall not be delivered unless the Series 2014 Bonds are then rated by a nationally recognized rating agency in one of the four highest rating categories for a long-term instrument.

(b) The Initial Bond is hereby authorized to be issued, sold, and delivered hereunder as a single fully registered Series 2014 Bond, without interest coupons, in the denomination and aggregate principal amount set forth in the Approval Certificate (not exceeding $230,000,000) numbered TR-1, payable in annual installments of principal to the initial registered owner thereof or to the registered assignee or assignees of said Series 2014 Bond or any portion or portions thereof (in each case, the "registered owner"), with the annual installments of principal of the Initial Bond to be payable on the dates, respectively, and in the principal amounts, respectively, and may and shall be prepaid or redeemed prior to the respective scheduled due dates of installments of principal thereof, all as set forth in the Approval Certificate.

(c) The Initial Bond (i) may and, if so provided in the Approval Certificate, shall be prepaid or paid on the respective scheduled due dates of installments of principal thereof, (ii) may be assigned and transferred, (iii) may be converted and exchanged for other bonds, (iv) shall have the characteristics, and (v) shall be signed and sealed, and the principal of and interest on the Initial Bond shall be payable, all as provided, and in the manner required or indicated, in the FORM OF INITIAL BOND set forth in this Resolution.

Section 4. INTEREST. The unpaid principal balance of the Initial Bond shall bear interest from the dated date thereof to the respective scheduled due dates, or to the respective dates of prepayment or redemption, of the installments of principal of the Initial Bond, and such interest shall be payable in the manner, at the rates, and on the dates, respectively, as provided in the FORM OF INITIAL BOND, set forth in this Resolution.

Section 5. FORM OF INITIAL BOND. The form of the Initial Bond, including the form of Registration Certificate of the Comptroller of Public Accounts of the State of Texas to be endorsed on the Initial Bond, shall be substantially as follows:

FORM OF INITIAL BOND

NO. TR-1 $_____*

UNITED STATES OF AMERICA
STATE OF TEXAS
TARRANT REGIONAL WATER DISTRICT,
A WATER CONTROL AND IMPROVEMENT DISTRICT,
WATER TRANSMISSION FACILITIES CONTRACT REVENUE BOND
(CITY OF DALLAS PROJECT),
SERIES 2014

TARRANT REGIONAL WATER DISTRICT, A WATER CONTROL AND IMPROVEMENT DISTRICT (the "Issuer"), being a political subdivision of the State of Texas, hereby promises to pay to _____* or to the registered assignee or assignees of this Bond or any portion or portions hereof (in each case, the "registered owner") the aggregate principal amount of _____* and __/100 Dollars ($_____*) in annual installments of principal due and payable on September 1 in each of the years, in the respective principal amounts, and bearing interest at the respective interest rates, as set forth in the following schedule:

*From Approval Certificate.

Year*	Principal Amount*	Interest Rates*	Year*	Principal Amount*	Interest Rates*
	$	%		$	%

Interest will be payable, calculated on the basis of a 360-day year composed of twelve 30-day months, from the date of initial delivery of this Bond to the Underwriters (as defined in the Bond Resolution (hereinafter defined)), on the balance of each such installment of principal, with said interest being payable semiannually on each March 1 and September 1, commencing _____*, while this Bond or any portion hereof is outstanding and unpaid.

THE INSTALLMENTS OF PRINCIPAL OF AND THE INTEREST ON this Bond are payable in lawful money of the United States of America, without exchange or collection charges. The installments of principal and the interest on this Bond are payable to the registered owner hereof through the services of BOKF, NA dba BANK OF TEXAS, DALLAS, TEXAS, which is the "Paying Agent/Registrar" for this Bond. Payment of all principal of and interest on this Bond shall be made by the Paying Agent/Registrar to the registered owner hereof on each principal and/or interest payment date by check, dated as of such date, drawn by the Paying Agent/Registrar on, and payable solely from, funds of the Issuer required by the resolution authorizing the issuance of this Bond (the "Bond Resolution") to be on deposit with the Paying Agent/Registrar for such purpose as hereinafter provided; and such check shall be sent by the Paying Agent/Registrar by United States mail, first-class postage prepaid, on each such principal and/or interest payment date, to the registered owner hereof, at the address of the registered owner, as it appeared at the close of business on the 15th day of the month next preceding each such date (the "Record Date") on the Registration Books kept by the Paying Agent/ Registrar, as hereinafter described. The Issuer covenants with the registered owner of this Bond that on or before each principal and/or interest payment date for this Bond it will make available to the Paying Agent/Registrar, from the "Interest and Redemption Fund" created by the Bond Resolution, the amounts required to provide for the payment, in immediately available funds, of all principal of and interest on this Bond, when due.

IF THE DATE for the payment of the principal of or interest on this Bond shall be a Saturday, Sunday, a legal holiday, or a day on which banking institutions in the city where the Paying Agent/Registrar is located are authorized by law or executive order to close, then the date for such payment shall be the next succeeding day which is not such a Saturday, Sunday, legal holiday, or day on which banking institutions are authorized to close; and payment on such date shall have the same force and effect as if made on the original date payment was due.

THIS BOND has been authorized in accordance with the Constitution and laws of the State of Texas in the principal amount of $_____*, for the purpose of obtaining funds to (i) pay for design, acquisition, and construction costs related to the Dallas Project Component of the Project,

*From Approval Certificate.

as such terms are defined in the Bond Resolution, consisting generally of a portion of the share of the City of Dallas, Texas (the "City") of the costs of an integrated pipeline to serve the City and the Issuer, (ii) fund a reserve fund for this Bond, and (iii) pay costs of issuance of this Bond.

ON _____ 1, ____*, or any date thereafter, the unpaid installments of principal of this Bond may be prepaid or redeemed prior to their scheduled due dates, at the option of the Issuer, with funds derived from any available source, as a whole, or in part, and, if in part, the Issuer shall select and designate the installment or installment of principal, and the amount that is to be redeemed, and if less than a whole principal installment is to be called, the Issuer shall direct the Paying Agent/Registrar to call by lot or other customary method of random selection the portion of the principal installment to be redeemed (only in an integral multiple of $5,000), at the redemption price of the principal amount to be prepaid or redeemed, plus accrued interest to the date fixed for prepayment or redemption.

**[THE PRINCIPAL INSTALLMENTS OF THIS BOND maturing on September 1, ____ and September 1, ____ are subject to mandatory prepayment or redemption prior to maturity in part, at a price equal to the principal amount of this Bond or portions hereof to be prepaid or redeemed plus accrued interest to the date of prepayment or redemption, on September 1 in the each of years and in the amounts as follows:

Principal Installment due on September 1, ____

Years	Amounts

Principal Installment due on September 1, ____

Years	Amounts

The amount of any principal installment of this Bond required to be prepaid or redeemed pursuant to the operation of such mandatory prepayment or redemption provisions shall be reduced, at the option of the Issuer, by the principal amount of such principal installment of this Bond which, at least 50 days prior to the mandatory prepayment or redemption date (1) shall have been acquired by the Issuer at a price not exceeding such principal amount plus accrued interest to the date of purchase thereof, (2) shall have been purchased by the Paying Agent/Registrar at the request of the Issuer at a price not exceeding such principal amount plus accrued interest to the date of purchase,

* From Approval Certificate.
** From Approval Certificate, if applicable.

or (3) shall have been prepaid or redeemed pursuant to the optional prepayment or redemption provisions and not theretofore credited against a mandatory prepayment or redemption requirement.]

AT LEAST 30 days prior to the date fixed for any such prepayment or redemption a written notice of such prepayment or redemption shall be mailed by the Paying Agent/Registrar to the registered owner hereof. By the date fixed for any such prepayment or redemption due provision shall be made by the Issuer with the Paying Agent/Registrar for the payment of the required prepayment or redemption price for this Bond or the portion hereof which is to be so prepaid or redeemed, plus accrued interest thereon to the date fixed for prepayment or redemption. If such written notice of prepayment or redemption is given, and if due provision for such payment is made, all as provided above, this Bond, or the portion thereof which is to be so prepaid or redeemed, thereby automatically shall be treated as prepaid or redeemed prior to its scheduled due date, and shall not bear interest after the date fixed for its prepayment or redemption, and shall not be regarded as being outstanding except for the right of the registered owner to receive the prepayment or redemption price plus accrued interest to the date fixed for prepayment or redemption from the Paying Agent/Registrar out of the funds provided for such payment. The Paying Agent/Registrar shall record in the Registration Books all such prepayments or redemptions of principal of this Bond or any portion hereof.

THIS BOND, to the extent of the unpaid or unredeemed principal balance hereof, or any unpaid and unredeemed portion hereof in any integral multiple of $5,000, may be assigned by the initial registered owner hereof and shall be transferred only in the Registration Books of the Issuer kept by the Paying Agent/Registrar acting in the capacity of registrar for the Bonds, upon the terms and conditions set forth in the Bond Resolution. Among other requirements for such transfer, this Bond must be presented and surrendered to the Paying Agent/ Registrar for cancellation, together with proper instruments of assignment, in form and with guarantee of signatures satisfactory to the Paying Agent/Registrar, evidencing assignment by the initial registered owner of this Bond, or any portion or portions hereof in any integral multiple of $5,000, to the assignee or assignees in whose name or names this Bond or any such portion or portions hereof is or are to be transferred and registered. Any instrument or instruments of assignment satisfactory to the Paying Agent/Registrar may be used to evidence the assignment of this Bond or any such portion or portions hereof by the initial registered owner hereof. A new bond or bonds payable to such assignee or assignees (which then will be the new registered owner or owners of such new Bond or Bonds) or to the initial registered owner as to any portion of this Bond which is not being assigned and transferred by the initial registered owner, shall be delivered by the Paying Agent/Registrar in conversion of and exchange for this Bond or any portion or portions hereof, but solely in the form and manner as provided in the next paragraph hereof for the conversion and exchange of this Bond or any portion hereof. The registered owner of this Bond shall be deemed and treated by the Issuer and the Paying Agent/Registrar as the absolute owner hereof for all purposes, including payment and discharge of liability upon this Bond to the extent of such payment, and the Issuer and the Paying Agent/Registrar shall not be affected by any notice to the contrary.

AS PROVIDED above and in the Bond Resolution, this Bond, to the extent of the unpaid or unredeemed principal balance hereof, may be converted into and exchanged for a like aggregate principal amount of fully registered bonds, without interest coupons, payable to the assignee or assignees duly designated in writing by the initial registered owner hereof, or to the initial registered

owner as to any portion of this Bond which is not being assigned and transferred by the initial registered owner, in any denomination or denominations in any integral multiple of $5,000 (subject to the requirement hereinafter stated that each substitute bond issued in exchange for any portion of this Bond shall have a single stated principal maturity date), upon surrender of this Bond to the Paying Agent/Registrar for cancellation, all in accordance with the form and procedures set forth in the Bond Resolution. If this Bond or any portion hereof is assigned and transferred or converted each bond issued in exchange for any portion hereof shall have a single stated principal maturity date corresponding to the due date of the installment of principal of this Bond or portion hereof for which the substitute bond is being exchanged, and shall bear interest at the rate applicable to and borne by such installment of principal or portion thereof. Such bonds, respectively, shall be subject to redemption prior to maturity on the same dates and for the same prices as the corresponding installment of principal of this Bond or portion hereof for which they are being exchanged. No such bond shall be payable in installments, but shall have only one stated principal maturity date. AS PROVIDED IN THE BOND RESOLUTION, THIS BOND IN ITS PRESENT FORM MAY BE ASSIGNED AND TRANSFERRED OR CONVERTED ONCE ONLY, and to one or more assignees, but the bonds issued and delivered in exchange for this Bond or any portion hereof may be assigned and transferred, and converted, subsequently, as provided in the Bond Resolution. The Issuer shall pay the Paying Agent/Registrar's standard or customary fees and charges for transferring, converting, and exchanging this Bond or any portion thereof, but the one requesting such transfer, conversion, and exchange shall pay any taxes or governmental charges required to be paid with respect thereto. The Paying Agent/Registrar shall not be required to make any such assignment, conversion, or exchange (i) during the period commencing with the close of business on any Record Date and ending with the opening of business on the next following principal or interest payment date, or, (ii) with respect to any Bond or portion thereof called for prepayment or redemption prior to maturity, within 45 days prior to its prepayment or redemption date.

IN THE EVENT any Paying Agent/Registrar for this Bond is changed by the Issuer, resigns, or otherwise ceases to act as such, the Issuer has covenanted in the Bond Resolution that it promptly will appoint a competent and legally qualified substitute therefor, and promptly will cause written notice thereof to be mailed to the registered owner of this Bond.

IT IS HEREBY certified, recited, and covenanted that this Bond has been duly and validly authorized, issued, and delivered; that all acts, conditions, and things required or proper to be performed, exist, and be done precedent to or in the authorization, issuance, and delivery of this Bond have been performed, existed, and been done in accordance with law; that this Bond and the interest thereon are special obligations of the Issuer which, together with other outstanding parity revenue bonds of the Issuer, are payable from and secured by a first lien on and pledge of the "Gross Revenues", as defined in the Bond Resolution, consisting of payments received by the Issuer from the City, designated as "Dallas Bond Payments", pursuant to a Water Transmission Facilities Financing Agreement, dated November 16, 2010 (the "Contract"), between the Issuer and the City with respect to the acquisition, construction, and financing of an integrated pipeline designated as the "Project" in the Contract. It is specifically provided in the Contract that the City is obligated to make payments in amounts sufficient to pay the principal of and interest on this Bond, when due, and that such payments will be made solely from the gross revenues of the City's combined waterworks and sewer system.

THE ISSUER IS OBLIGATED TO PAY THE PRINCIPAL OF AND INTEREST ON THIS BOND SOLELY FROM AND TO THE EXTENT OF THE GROSS REVENUES DERIVED

FROM THE DALLAS BOND PAYMENTS TO BE RECEIVED FROM THE CITY. NO OTHER ENTITY, INCLUDING THE STATE OF TEXAS, ANY POLITICAL SUBDIVISION THEREOF (OTHER THAN THE CITY), OR ANY OTHER PUBLIC OR PRIVATE BODY, IS OBLIGATED, DIRECTLY, INDIRECTLY, CONTINGENTLY, OR IN ANY OTHER MANNER, TO PAY SUCH PRINCIPAL OR INTEREST FROM ANY OTHER SOURCE WHATSOEVER. THE OWNER OF THIS BOND SHALL NEVER HAVE THE RIGHT TO DEMAND PAYMENT OF THIS BOND OUT OF ANY FUNDS RAISED OR TO BE RAISED BY TAXATION (INCLUDING SPECIFICALLY TAXES RAISED OR TO BE RAISED BY THE CITY) OR FROM ANY OTHER FUNDS OF THE ISSUER EXCEPT THE GROSS REVENUES PLEDGED TO THE PAYMENT OF THIS BOND. NO REPRESENTATION IS MADE HEREIN WITH RESPECT TO THE ANTICIPATED SUFFICIENCY OF THE GROSS REVENUES PLEDGED TO THE PAYMENT OF THIS BOND. NO PART OF THE PHYSICAL PROPERTY OF THE CITY IS ENCUMBERED BY ANY LIEN OR SECURITY INTEREST FOR THE BENEFIT OF THE OWNERS OF THIS BOND.

THE ISSUER has reserved the right, subject to the restrictions stated in the Bond Resolution, to issue Additional Bonds payable from and secured by a first lien on and pledge of the Gross Revenues on a parity with this Bond.

THE ISSUER also has reserved the right to amend the Bond Resolution, with the approval of the owners of 51% of the outstanding bonds secured by a first lien on the Gross Revenues, subject to the restrictions stated in the Bond Resolution.

THE REGISTERED OWNER hereof shall never have the right to demand payment of this Bond or the interest hereon from any source whatsoever other than specified in the Contract and the Bond Resolution.

BY BECOMING the registered owner of this Bond, the registered owner thereby acknowledges all of the terms and provisions of the Bond Resolution, agrees to be bound by such terms and provisions, acknowledges that the Bond Resolution is duly recorded and available for inspection in the official minutes and records of the governing body of the Issuer, and agrees that the terms and provisions of this Bond and the Bond Resolution constitute a contract between the registered owner hereof and the Issuer.

IN WITNESS WHEREOF, the Issuer has caused this Bond to be signed with the manual or facsimile signature of the President of the Board of Directors of the Issuer and countersigned with the manual or facsimile signature of the Secretary of the Board of Directors of the Issuer, has caused the official seal of the Issuer to be duly impressed, or placed in facsimile, on this Bond, and has caused this Bond to be dated as of _____, ____*.

_____ _____

Secretary, Board of Directors President, Board of Directors

(DISTRICT SEAL)

*From Approval Certificate.

FORM OF REGISTRATION CERTIFICATE OF THE
COMPTROLLER OF PUBLIC ACCOUNTS:

COMPTROLLER'S REGISTRATION CERTIFICATE: REGISTER NO.

I hereby certify that this Bond has been examined, certified as to validity, and approved by the Attorney General of the State of Texas, and that this Bond has been registered by the Comptroller of Public Accounts of the State of Texas.

Witness my signature and seal this

_____
Comptroller of Public Accounts of the State of Texas

(COMPTROLLER'S SEAL)

Section 6. CHARACTERISTICS OF THE SERIES 2014 BONDS. (a) Registration, Transfer, Conversion and Exchange; Authentication. The Issuer shall keep or cause to be kept at the principal corporate trust office of BOKF, NA dba Bank of Texas, Dallas, Texas (the "Paying Agent/Registrar") books or records for the registration of the transfer, conversion and exchange of the Series 2014 Bonds (the "Registration Books"), and the Issuer hereby appoints the Paying Agent/Registrar as its registrar and transfer agent to keep such books or records and make such registrations of transfers, conversions and exchanges under such reasonable regulations as the Issuer and Paying Agent/Registrar may prescribe; and the Paying Agent/Registrar shall make such registrations, transfers, conversions and exchanges as herein provided. The Paying Agent/Registrar shall obtain and record in the Registration Books the address of the registered owner of each Series 2014 Bond to which payments with respect to the Series 2014 Bonds shall be mailed, as herein provided; but it shall be the duty of each registered owner to notify the Paying Agent/Registrar in writing of the address to which payments shall be mailed, and such interest payments shall not be mailed unless such notice has been given. To the extent possible and under reasonable circumstances, all transfers of Series 2014 Bonds shall be made within three Business Days after request and presentation thereof. The Issuer shall have the right to inspect the Registration Books during regular business hours of the Paying Agent/Registrar, but otherwise the Paying Agent/Registrar shall keep the Registration Books confidential and, unless otherwise required by law, shall not permit their inspection by any other entity. The Paying Agent/Registrar's standard or customary fees and charges for making such registration, transfer, conversion, exchange and delivery of a substitute Series 2014 Bond or Series 2014 Bonds shall be paid as provided in the FORM OF BOND set forth in this Resolution. Registration of assignments, transfers, conversions and exchanges of Series 2014 Bonds shall be made in the manner provided and with the effect stated in the FORM OF BOND set forth in this Resolution. Each substitute Bond shall bear a letter and/or number to distinguish it from each other Bond.

An authorized representative of the Paying Agent/Registrar shall, before the delivery of any such Bond, date and manually sign the Paying Agent/Registrar's Authentication Certificate, and no such Bond shall be deemed to be issued or outstanding unless such Certificate is so executed. The Paying Agent/Registrar promptly shall cancel all paid Series 2014 Bonds surrendered for conversion and exchange. No additional ordinances, orders, or resolutions need be passed or adopted by the

governing body of the Issuer or any other body or person so as to accomplish the foregoing conversion and exchange of any Bond or portion thereof, and the Paying Agent/Registrar shall provide for the printing, execution, and delivery of the substitute Series 2014 Bonds in the manner prescribed herein, and said Series 2014 Bonds shall be of type composition printed on paper with lithographed or steel engraved borders of customary weight and strength. Pursuant to Subchapter D, Chapter 1201, Texas Government Code, the duty of conversion and exchange of Series 2014 Bonds as aforesaid is hereby imposed upon the Paying Agent/Registrar, and, upon the execution of said Certificate, the converted and exchanged Series 2014 Bond shall be valid, incontestable, and enforceable in the same manner and with the same effect as the Series 2014 Bonds which initially were issued and delivered pursuant to this Resolution, approved by the Attorney General, and registered by the Comptroller of Public Accounts.

(b) Payment of Series 2014 Bonds and Interest. The Issuer hereby further appoints the Paying Agent/Registrar to act as the paying agent for paying the principal of and interest on the Series 2014 Bonds, all as provided in this Resolution. The Paying Agent/Registrar shall keep proper records of all payments made by the Issuer and the Paying Agent/Registrar with respect to the Series 2014 Bonds.

(c) In General. The Series 2014 Bonds (i) shall be issued in fully registered form, without interest coupons, with the principal of and interest on such Series 2014 Bonds to be payable only to the registered owners thereof, (ii) may be redeemed prior to their scheduled maturities, (iii) may be transferred and assigned, (iv) may be converted and exchanged for other Series 2014 Bonds, (v) shall have the characteristics, (vi) shall be signed, sealed, executed and authenticated, (vii) shall be payable as to principal and interest, and (viii) shall be administered and the Paying Agent/Registrar and the Issuer shall have certain duties and responsibilities with respect to the Series 2014 Bonds, all as provided, and in the manner and to the effect as required or indicated, in the FORM OF Series 2014 Bond set forth in this Resolution. The Series 2014 Bonds initially issued and delivered pursuant to this Resolution are not required to be, and shall not be, authenticated by the Paying Agent/Registrar, but on each substitute Series 2014 Bond issued in conversion of and exchange for any Series 2014 Bond or Series 2014 Bonds issued under this Resolution the Paying Agent/Registrar shall execute the PAYING AGENT/REGISTRAR'S AUTHENTICATION CERTIFICATE, in the form set forth in the FORM OF SERIES 2014 SUBSTITUTE BOND.

(d) Substitute Paying Agent/Registrar. The Issuer covenants with the registered owners of the Series 2014 Bonds that at all times while the Series 2014 Bonds are outstanding the Issuer will provide a competent and legally qualified bank, trust company, financial institution, or other agency to act as and perform the services of Paying Agent/Registrar for the Series 2014 Bonds under this Resolution, and that the Paying Agent/Registrar will be one entity. The Issuer reserves the right to, and may, at its option, change the Paying Agent/Registrar upon not less than 120 days written notice to the Paying Agent/Registrar, to be effective not later than 60 days prior to the next principal or interest payment date after such notice. In the event that the entity at any time acting as Paying Agent/Registrar (or its successor by merger, acquisition, or other method) should resign or otherwise cease to act as such, the Issuer covenants that promptly it will appoint a competent and legally qualified bank, trust company, financial institution, or other agency to act as Paying Agent/Registrar under this Resolution. Upon any change in the Paying Agent/Registrar, the previous Paying Agent/Registrar promptly shall transfer and deliver the Registration Books (or a copy thereof), along with all other pertinent books and records relating to the Series 2014 Bonds, to the new Paying

Agent/Registrar designated and appointed by the Issuer. Upon any change in the Paying Agent/Registrar, the Issuer promptly will cause a written notice thereof to be sent by the new Paying Agent/Registrar to each registered owner of the Series 2014 Bonds, by United States mail, first-class postage prepaid, which notice also shall give the address of the new Paying Agent/Registrar. By accepting the position and performing as such, each Paying Agent/Registrar shall be deemed to have agreed to the provisions of this Resolution, and a certified copy of this Resolution shall be delivered to each Paying Agent/Registrar.

(e) Reporting Requirements of Paying Agent/Registrar. To the extent required by the Internal Revenue Code of 1985 (the "Code") and the regulations promulgated and pertaining thereto, it shall be the duty of the Paying Agent/Registrar, on behalf of the Issuer, to report to the owners of the Series 2014 Bonds and the Internal Revenue Service (i) the amount of "reportable payments", if any, subject to backup withholding during each year and the amount of tax withheld, if any, with respect to payments of the Series 2014 Bonds and (ii) the amount of interest or amount treating as interest on the Series 2014 Bonds and required to be included in gross income of the owner thereof.

(f) Book-Entry Only System. The Series 2014 Bonds issued in exchange for the Series 2014 Bonds initially issued to the purchaser specified herein shall be initially issued in the form of a separate single fully registered Series 2014 Bond for each of the maturities thereof. Upon initial issuance, the ownership of each such Series 2014 Bond shall be registered in the name of Cede & Co., as nominee of Depository Trust Company of New York ("DTC"), and except as provided in subsection (f) hereof, all of the outstanding Series 2014 Bonds shall be registered in the name of Cede & Co., as nominee of DTC.

With respect to Series 2014 Bonds registered in the name of Cede & Co., as nominee of DTC, the Issuer and the Paying Agent/Registrar shall have no responsibility or obligation to any DTC Participant or to any person on behalf of whom such a DTC Participant holds an interest on the Series 2014 Bonds. Without limiting the immediately preceding sentence, the Issuer and the Paying Agent/Registrar shall have no responsibility or obligation with respect to (i) the accuracy of the records of DTC, Cede & Co. or any DTC Participant with respect to any ownership interest in the Series 2014 Bonds, (ii) the delivery to any DTC Participant or any other person, other than a Bondholder, as shown on the Registration Books, of any notice with respect to the Series 2014 Bonds, including any notice of redemption, or (iii) the payment to any DTC Participant or any other person, other than a Bondholder, as shown in the Registration Books of any amount with respect to principal of, premium, if any, or interest on, as the case may be, the Series 2014 Bonds. Notwithstanding any other provision of this Resolution to the contrary, the Issuer and the Paying Agent/Registrar shall be entitled to treat and consider the person in whose name each Series 2014 Bond is registered in the Registration Books as the absolute owner of such Series 2014 Bond for the purpose of payment of principal, premium, if any, and interest, as the case may be, with respect to such Bond, for the purpose of giving notices of redemption and other matters with respect to such Bond, for the purpose of registering transfers with respect to such Bond, and for all other purposes whatsoever. The Paying Agent/Registrar shall pay all principal of, premium, if any, and interest on the Series 2014 Bonds only to or upon the order of the respective owners, as shown in the Registration Books as provided in this Resolution, or their respective attorneys duly authorized in writing, and all such payments shall be valid and effective to fully satisfy and discharge the Issuer's obligations with respect to payment of principal of, premium, if any, and interest on, or as the case may be, the Series 2014 Bonds to the extent of the sum or sums so paid. No person other than an

owner, as shown in the Registration Books, shall receive a Series 2014 Bond certificate evidencing the obligation of the Issuer to make payments of principal, premium, if any, and interest, as the case may be, pursuant to this Resolution. Upon delivery by DTC to the Paying Agent/Registrar of written notice to the effect that DTC has determined to substitute a new nominee in place of Cede & Co., and subject to the provisions in this Resolution with respect to interest checks being mailed to the registered owner at the close of business on the Record Date, the word "Cede & Co." in this Resolution shall refer to such new nominee of DTC. The Issuer has executed and delivered to DTC a "Blanket Letter of Representation" to effect the use of a book-entry-only system for obligations such as the Series 2014 Bonds.

(g) Successor Securities Depository; Transfers Outside Book-Entry Only System. In the event that the Issuer or the Paying Agent/Registrar determines that DTC is incapable of discharging its responsibilities described herein and in the Blanket Letter of Representation of the Issuer to DTC and that it is in the best interest of the beneficial owners of the Series 2014 Bonds that they be able to obtain certificated Series 2014 Bonds, the Issuer or the Paying Agent/Registrar shall (i) appoint a successor securities depository, qualified to act as such under Section 17(a) of the Securities and Exchange Act of 1934, as amended, notify DTC and DTC Participants of the appointment of such successor securities depository and transfer one or more separate Series 2014 Bonds to such successor securities depository or (ii) notify DTC and DTC Participants of the availability through DTC of Series 2014 Bonds and transfer one or more separate Series 2014 Bonds to DTC Participants having Series 2014 Bonds credited to their DTC accounts. In such event, the Series 2014 Bonds shall no longer be restricted to being registered in the Registration Books in the name of Cede & Co., as nominee of DTC, but may be registered in the name of the successor securities depository, or its nominee, or in whatever name or names Bondholders transferring or exchanging Series 2014 Bonds shall designate, in accordance with the provisions of this Resolution.

(h) Payments to Cede & Co. Notwithstanding any other provision of this Resolution to the contrary, so long as any Bond is registered in the name of Cede & Co., as nominee of DTC, all payments with respect to principal of, premium, if any, and interest on, or as the case may be, such Bond and all notices with respect to such Bond shall be made and given, respectively, in the manner provided in the representation letter of the Issuer to DTC.

Section 7. FORM OF SERIES 2014 SUBSTITUTE BONDS. The form of all Series 2014 Bonds issued in conversion and exchange or replacement of any other Series 2014 Bond or portion thereof, including the form of Paying Agent/Registrar's Certificate to be printed on each of such Series 2014 Bonds, and the Form of Assignment to be printed on each of the Series 2014 Bonds, shall be, respectively, substantially as follows, with such appropriate variations, omissions, or insertions as are permitted or required by this Resolution.

FORM OF SERIES 2014 SUBSTITUTE BOND

NO.____ PRINCIPAL AMOUNT
$_____

UNITED STATES OF AMERICA
STATE OF TEXAS
TARRANT REGIONAL WATER DISTRICT,
A WATER CONTROL AND IMPROVEMENT DISTRICT,
WATER TRANSMISSION FACILITIES CONTRACT REVENUE BOND
(CITY OF DALLAS, TEXAS PROJECT),
SERIES 2014

INTEREST RATE	MATURITY DATE	ISSUE DATE	CUSIP NO.
%	September 1, ____	_____*, 2014	

ON THE MATURITY DATE specified above TARRANT REGIONAL WATER DISTRICT, A WATER CONTROL AND IMPROVEMENT DISTRICT (the "Issuer"), being a political subdivision of the State of Texas, hereby promises to pay to CEDE & CO. or to the registered assignee hereof (either being hereinafter called the "registered owner") the principal amount of _____ DOLLARS and to pay interest thereon, calculated on the basis of a 360-day year composed of twelve 30-day months, from the Issue Date specified above, to the Maturity Date specified above, or the date of redemption prior to maturity, at the interest rate per annum specified above; with interest being payable semiannually on each March 1 and September 1, commencing _____**, except that if the date of authentication of this Bond is later than the first Record Date (hereinafter defined), such principal amount shall bear interest from the interest payment date next preceding the date of authentication, unless such date of authentication is after any Record Date (hereinafter defined) but on or before the next following interest payment date, in which case such principal amount shall bear interest from such next following interest payment date.

THE PRINCIPAL OF AND INTEREST ON this Bond are payable in lawful money of the United States of America, without exchange or collection charges. The principal of this Bond shall be paid to the registered owner hereof upon presentation and surrender of this Bond at maturity or upon the date fixed for its redemption prior to maturity, at the principal corporate trust office of BOKF, NA dba BANK OF TEXAS, Dallas, Texas, which is the "Paying Agent/Registrar" for this Bond. The payment of interest on this Bond shall be made by the Paying Agent/Registrar to the registered owner hereof on each interest payment date by check dated as of such interest payment date, drawn by the Paying Agent/Registrar on, and payable solely from, funds of the Issuer required by the resolution authorizing the issuance of the Bonds (the "Bond Resolution") to be on deposit with the Paying Agent/Registrar for such purpose as hereinafter provided; and such check shall be sent by the Paying Agent/Registrar by United States mail, first-class postage prepaid, on each such interest payment date, to the registered owner hereof, at the address of the registered owner, as it appeared at the close of business on the 15th day of the month next preceding each such date (the

* Date of initial delivery to the Underwriters (as defined in Section 33 hereof).
** From Approval Certificate.

"Record Date") on the Registration Books kept by the Paying Agent/Registrar, as hereinafter described. However, notwithstanding the foregoing provisions, (1) the payment of such interest may be made by any other method acceptable to the Paying Agent/Registrar and requested by, and at the risk and expense of, the registered owner hereof and (2) upon the written request, and at the risk and expense of, the registered owner of any Bond of this Series in the amount of $1,000,000 or more, delivered to the Paying Agent/Registrar not less than 15 days prior to any interest payment date, payment of the interest due on such Bond on such date shall be paid on such date by wire transfer to any designated account in the United States of America which has available to it the wire service facilities of the Federal Reserve Bank. Any accrued interest due upon the redemption of this Bond prior to maturity as provided herein shall be paid to the registered owner at the principal corporate trust office of the Paying Agent/Registrar upon presentation and surrender of this Bond for redemption and payment at the principal corporate trust office of the Paying Agent/Registrar. The Issuer covenants with the registered owner of this Bond that on or before each principal payment date, interest payment date, and accrued interest payment date for this Bond it will make available to the Paying Agent/Registrar, from the "Interest and Redemption Fund" created by the Bond Resolution, the amounts required to provide for the payment, in immediately available funds, of all principal of and interest on the Bonds, when due.

IF THE DATE for the payment of the principal of or interest on this Bond shall be a Saturday, Sunday, a legal holiday, or a day on which banking institutions in the city where the Paying Agent/Registrar is located are authorized by law or executive order to close, then the date for such payment shall be the next succeeding day which is not such a Saturday, Sunday, legal holiday, or day on which banking institutions are authorized to close; and payment on such date shall have the same force and effect as if made on the original date payment was due.

THIS BOND is one of a series of bonds (the "Bonds") dated as of _____*, 2014, authorized in accordance with the Constitution and laws of the State of Texas in the principal amount of $_____* for the purpose of obtaining funds to (i) pay for design, acquisition, and constructions costs related to the Dallas Project Component of the Project, as such terms are defined in the Bond Resolution, consisting generally of a portion of the share of the City of Dallas, Texas (the "City") of the costs of an integrated pipeline to serve the City and the Issuer, (ii) fund a reserve fund for the Bonds, and (iii) pay costs of issuance of the Bonds.

ON _____, ____*, or any date thereafter, the Bonds may be redeemed prior to their scheduled maturities, at the option of the Issuer, with funds derived from any available source, as a whole, or in part, and, if in part, the Issuer shall select and designate the particular maturities and amounts of Bonds to be redeemed, and if less than all of the Bonds of a maturity are to be redeemed, the Issuer shall direct the Paying Agent/Registrar to call by lot or other customary method of random selection the particular Bonds or portions thereof to be redeemed (only in an integral multiple of $5,000), at the redemption price of the principal amount to be redeemed, plus accrued interest to the date fixed for redemption.

** From Approval Certificate.

*[THE BONDS maturing on September 1, ____ and September 1, ____ (the "Term Bonds") are subject to mandatory redemption prior to maturity in part, by lot or other customary random method selected by the Paying Agent/Registrar, at a redemption price equal to the principal amount of the Term Bonds or portions thereof to be redeemed plus accrued interest to the redemption date, on September 1 in each of the years and in the principal amounts as follows:

Term Bonds maturing on September 1, ____

Years	Amounts

Term Bonds maturing on September 1, ____

Years	Amounts

The principal amount of the Term Bonds of a maturity required to be redeemed pursuant to the operation of such mandatory redemption provisions shall be reduced, at the option of the Issuer, by the principal amount of the Term Bonds of such maturity which, at least 50 days prior to the mandatory redemption date (1) shall have been acquired by the Issuer at a price not exceeding the principal amount of such Term Bonds plus accrued interest to the date of purchase thereof, and delivered to the Paying Agent/Registrar for cancellation, (2) shall have been purchased and canceled by the Paying Agent/Registrar at the request of the Issuer at a price not exceeding the principal amount of such Term Bonds plus accrued interest to the date of purchase, or (3) shall have been redeemed pursuant to the optional redemption provisions and not theretofore credited against a mandatory redemption requirement.]

DURING ANY PERIOD in which ownership of the Bonds is determined by a book entry at a securities depository for the Bonds, if fewer than all of the Bonds of the same maturity and bearing the same interest rate are to be redeemed, the particular Bonds of such maturity and bearing such interest rate shall be selected in accordance with the arrangements between the Issuer and the securities depository.

AT LEAST 30 days prior to the date fixed for any redemption of Bonds or portions thereof prior to maturity at the option of the Issuer, a written notice of such redemption shall be sent by the Paying Agent/Registrar by United States mail, first-class postage prepaid, to the registered owner appearing on the Registration Books at the close of business on the day next preceding the date of mailing of such notice; provided, however, that any notice so mailed shall be conclusively presumed

* From Approval Certificate, if applicable.

to have been duly given and the failure to receive such notice, or any defect therein shall not affect the validity or effectiveness of the proceedings for the redemption of any Bond at the option of the Issuer. By the date fixed for any such redemption due provision shall be made with the Paying Agent/Registrar for the payment of the required redemption price for the Bonds or portions thereof which are to be so redeemed, plus accrued interest thereon to the date fixed for redemption. If such written notice of redemption is mailed and if due provision for such payment is made, all as provided above, the Bonds or portions thereof which are to be so redeemed thereby automatically shall be treated as redeemed prior to their scheduled maturities, and they shall not bear interest after the date fixed for redemption, and they shall not be regarded as being outstanding except for the right of the registered owner to receive the redemption price plus accrued interest from the Paying Agent/Registrar out of the funds provided for such payment. If a portion of any Bond shall be redeemed a substitute Bond or Bonds having the same maturity date, bearing interest at the same rate, in any denomination or denominations in any integral multiple of $5,000, at the written request of the registered owner, and in aggregate principal amount equal to the unredeemed portion thereof, will be issued to the registered owner upon the surrender thereof for cancellation, at the expense of the Issuer, all as provided in the Bond Resolution.

THIS BOND OR ANY PORTION OR PORTIONS HEREOF IN ANY INTEGRAL MULTIPLE OF $5,000 may be assigned and shall be transferred only in the Registration Books of the Issuer kept by the Paying Agent/Registrar acting in the capacity of registrar for the Bonds, upon the terms and conditions set forth in the Bond Resolution. Among other requirements for such assignment and transfer, this Bond must be presented and surrendered to the Paying Agent/Registrar, together with proper instruments of assignment, in form and with guarantee of signatures satisfactory to the Paying Agent/Registrar, evidencing assignment of this Bond or any portion or portions hereof in any integral multiple of $5,000 to the assignee or assignees in whose name or names this Bond or any such portion or portions hereof is or are to be transferred and registered. The form of Assignment printed or endorsed on this Bond shall be executed by the registered owner or its duly authorized attorney or representative, to evidence the assignment hereof. A new Bond or Bonds payable to such assignee or assignees (which then will be the new registered owner or owners of such new Bond or Bonds), or to the previous registered owner in the case of the assignment and transfer of only a portion of this Bond, may be delivered by the Paying Agent/Registrar in conversion of and exchange for this Bond, all in the form and manner as provided in the next paragraph hereof for the conversion and exchange of other bonds. The Issuer shall pay the Paying Agent/Registrar's standard or customary fees and charges for making such transfer, but the one requesting such transfer shall pay any taxes or other governmental charges required to be paid with respect thereto. The Paying Agent/Registrar shall not be required to make transfers of registration of this Bond or any portion hereof (i) during the period commencing with the close of business on any Record Date and ending with the opening of business on the next following principal or interest payment date, or, (ii) with respect to any Bond or any portion thereof called for redemption prior to maturity, within 45 days prior to its redemption date. The registered owner of this Bond shall be deemed and treated by the Issuer and the Paying Agent/Registrar as the absolute owner hereof for all purposes, including payment and discharge of liability upon this Bond to the extent of such payment, and the Issuer and the Paying Agent/Registrar shall not be affected by any notice to the contrary.

ALL BONDS OF THIS SERIES are issuable solely as fully registered bonds, without interest coupons, in the denomination of any integral multiple of $5,000. As provided in the Bond Resolution, this Bond, or any unredeemed portion hereof, may, at the request of the registered owner or the assignee or assignees hereof, be converted into and exchanged for a like aggregate principal amount of fully registered bonds, without interest coupons, payable to the appropriate registered owner, assignee, or assignees, as the case may be, having the same maturity date, and bearing interest at the same rate, in any denomination or denominations in any integral multiple of $5,000 as requested in writing by the appropriate registered owner, assignee, or assignees, as the case may be, upon surrender of this Bond to the Paying Agent/Registrar for cancellation, all in accordance with the form and procedures set forth in the Bond Resolution. The Issuer shall pay the Paying Agent/Registrar's standard or customary fees and charges for transferring, converting, and exchanging any Bond or any portion thereof, but the one requesting such transfer, conversion, and exchange shall pay any taxes or governmental charges required to be paid with respect thereto as a condition precedent to the exercise of such privilege of conversion and exchange. The Paying Agent/Registrar shall not be required to make any such conversion and exchange (i) during the period commencing with the close of business on any Record Date and ending with the opening of business on the next following principal or interest payment date, or, (ii) with respect to any Bond or portion thereof called for redemption prior to maturity, within 45 days prior to its redemption date.

IN THE EVENT any Paying Agent/Registrar for this Bond is changed by the Issuer, resigns, or otherwise ceases to act as such, the Issuer has covenanted in the Bond Resolution that it promptly will appoint a competent and legally qualified substitute therefor, and promptly will cause written notice thereof to be mailed to the registered owners of this Bond.

IT IS HEREBY certified, recited, and covenanted that this Bond has been duly and validly authorized, issued, and delivered; that all acts, conditions, and things required or proper to be performed, exist, and be done precedent to or in the authorization, issuance, and delivery of this Bond have been performed, existed, and been done in accordance with law; that this Bond and the interest thereon are special obligations of the Issuer, which, together with other outstanding parity revenue bonds of the Issuer, are payable from and secured by a first lien on and pledge of the "Gross Revenues", as defined in the Bond Resolution, consisting of payments received by the Issuer from the City designated as "Dallas Bond Payments", pursuant to a Water Transmission Facilities Financing Agreement, dated November 16, 2010 (the "Contract"), between the Issuer and the City with respect to the acquisition, construction, and financing of an integrated pipeline designated as the "Project" in the Contract. It is specifically provided in the Contract that the City is obligated to make payments in amounts sufficient to pay the principal of and interest on this Bond, when due, and that such payments will be made solely from the gross revenues of the City's combined waterworks and sewer system.

THE ISSUER IS OBLIGATED TO PAY THE PRINCIPAL OF AND INTEREST ON THIS BOND SOLELY FROM AND TO THE EXTENT OF THE GROSS REVENUES DERIVED FROM THE DALLAS BOND PAYMENTS TO BE RECEIVED FROM THE CITY. NO OTHER ENTITY, INCLUDING THE STATE OF TEXAS, ANY POLITICAL SUBDIVISION THEREOF (OTHER THAN THE CITY), OR ANY OTHER PUBLIC OR PRIVATE BODY, IS OBLIGATED, DIRECTLY, INDIRECTLY, CONTINGENTLY, OR IN ANY OTHER MANNER, TO PAY SUCH PRINCIPAL OR INTEREST FROM ANY OTHER SOURCE WHATSOEVER. THE OWNER OF

THIS BOND SHALL NEVER HAVE THE RIGHT TO DEMAND PAYMENT OF THIS BOND OUT OF ANY FUNDS RAISED OR TO BE RAISED BY TAXATION (INCLUDING SPECIFICALLY TAXES RAISED OR TO BE RAISED BY THE CITY) OR FROM ANY OTHER FUNDS OF THE ISSUER EXCEPT THE GROSS REVENUES PLEDGED TO THE PAYMENT OF THIS BOND. NO REPRESENTATION IS MADE HEREIN WITH RESPECT TO THE ANTICIPATED SUFFICIENCY OF THE GROSS REVENUES PLEDGED TO THE PAYMENT OF THIS BOND. NO PART OF THE PHYSICAL PROPERTY OF THE CITY IS ENCUMBERED BY ANY LIEN OR SECURITY INTEREST FOR THE BENEFIT OF THE OWNERS OF THIS BOND.

THE ISSUER has reserved the right, subject to the restrictions stated in the Bond Resolution, to issue Additional Bonds payable from and secured by a first lien on and pledge of the Gross Revenues on a parity with this Bond.

THE ISSUER also has reserved the right to amend the Bond Resolution, with the approval of the owners of 51% of the outstanding bonds secured by a first lien on the Gross Revenues, subject to the restrictions stated in the Bond Resolution.

THE REGISTERED OWNER hereof shall never have the right to demand payment of this Bond or the interest hereon from any source whatsoever other than specified in the Contract and the Bond Resolution.

BY BECOMING the registered owner of this Bond, the registered owner thereby acknowledges all of the terms and provisions of the Bond Resolution, agrees to be bound by such terms and provisions, acknowledges that the Bond Resolution is duly recorded and available for inspection in the official minutes and records of the governing body of the Issuer, and agrees that the terms and provisions of this Bond and the Bond Resolution constitute a contract between each registered owner hereof and the Issuer.

IN WITNESS WHEREOF, the Issuer has caused this Bond to be signed with the facsimile signature of the President of the Board of Directors of the Issuer and countersigned with the facsimile signature of the Secretary of the Board of Directors of the Issuer, and has caused the official seal of the Issuer to be duly impressed, or placed in facsimile, on this Bond.

XXXXX	XXXXX
Secretary, Board of Directors	President, Board of Directors

(DISTRICT SEAL)

FORM OF PAYING AGENT/REGISTRAR'S AUTHENTICATION CERTIFICATE

PAYING AGENT/REGISTRAR'S AUTHENTICATION CERTIFICATE

(To be executed if this Bond is not accompanied by an executed Registration Certificate of the Comptroller of Public Accounts of the State of Texas)

It is hereby certified that this Bond has been issued under the provisions of the Bond Resolution described in the text of this Bond; and that this Bond has been issued in conversion or replacement of, or in exchange for, a bond, bonds, or a portion of a bond or bonds of a series which originally was approved by the Attorney General of the State of Texas and registered by the Comptroller of Public Accounts of the State of Texas.

Dated

BOKF, NA dba BANK OF TEXAS,
Dallas, Texas

By _____
Authorized Representative

FORM OF ASSIGNMENT:

ASSIGNMENT

FOR VALUE RECEIVED, the undersigned sells, assigns and transfers unto

Please Insert Social Security or
Other Identifying Number of Assignee

/_____/

_____

(Name and Address of Assignee)

the within Bond and does hereby irrevocably constitute and appoint _____ to transfer said Bond on the books kept for registration thereof with full power of substitution in the premises.

Date: _____

_____

Signature Guaranteed: _____

NOTICE: The signature to this assignment must correspond with the name as it appears upon the face of the within Bond in every particular, without alteration or enlargement or any change whatever; and

NOTICE: Signature(s) must be guaranteed by an eligible guarantor institution participating in a Securities Transfer Association recognized signature guarantee program.

Section 8. ADDITIONAL DEFINITIONS. In addition to the definitions heretofore provided for, the following terms as used in this Resolution shall have the meanings set forth below, unless the text hereof specifically indicates otherwise:

The term "Additional Bonds" shall mean the additional parity revenue bonds permitted to be authorized in the future on a parity with the Bonds, as hereinafter provided in Section 19 hereof.

The term "Board" shall mean the Board of Directors of the District, being the governing body of the District, and it is further resolved that the declarations and covenants of the District contained in this Resolution are made by, and for and on behalf of the Board and the District, and are binding upon the Board and the District for all purposes.

The terms "Bond Resolution" and "Resolution" shall mean this resolution authorizing the Series 2014 Bonds.

The term "Bonds" shall mean (i) the unpaid and unrefunded Series 2012 Bonds to be outstanding after the delivery of the Series 2014 Bonds, (ii) the Series 2014 Bonds, and (ii) any Additional Bonds.

The term "Business Day" shall mean a day other than a Saturday, a Sunday, a legal holiday, or a day on which banking institutions are authorized by law or executive order to close in the City or the city where the principal corporate trust office of the Paying Agent/Registrar is located.

The term "City" shall mean the City of Dallas, Texas.

The term "Contract" shall mean the "Water Transmission Facilities Financing Agreement," dated November 16, 2010, between the Issuer and the City.

The term "Credit Facility" shall mean (i) a policy of insurance or a surety bond, issued by an issuer of policies of insurance insuring the timely payment of debt service on governmental obligations, provided that a nationally recognized rating agency having an outstanding rating on outstanding Bonds would rate the Bonds fully insured by a standard policy issued by the issuer on the date the policy of insurance or surety bond is issued in its two highest generic rating categories for such obligations; and (ii) a letter or line of credit issued by any financial institution, provided that a rating agency having an outstanding rating on the Bonds would rate the Bonds in its two highest generic rating categories for such Bonds on the date such letter of line of credit is issued if the letter or line of credit proposed to be issued by such financial institution secured the timely payment of the entire principal amount of the Bonds and the interest thereon.

The term "Dallas Bond Payments" shall mean the payments received by the Issuer from the City pursuant to Contract and designated in the Contract as "Dallas Bond Payments."

The term "Dallas Project Component" shall have the same meaning given such term in the Contract.

The term "Gross Revenues" shall mean the Dallas Bond Payments received by the Issuer from the City pursuant to the Contract, together with any interest earnings thereon.

The terms "Issuer" and "District" shall mean Tarrant Regional Water District, a Water Control and Improvement District.

The term "Project" shall mean the integrated pipeline designated as the "Project" in the Contract.

The term "Series 2012 Bond Resolution" shall mean the resolution authorizing the issuance of the Series 2012 Bonds.

The term "Series 2012 Bonds" shall mean all unpaid and unrefunded "Tarrant Regional Water District, a Water Control and Improvement District, Water Transmission Facilities Contract Revenue Bonds (City of Dallas Project), Series 2012.

The term "Series 2014 Bonds" shall mean collectively the Initial Bond as described and defined in Sections 1, 2, and 3 of this Bond Resolution, and all substitute bonds exchanged therefor, as well as all other substitute bonds and replacement bonds issued pursuant to this Resolution, all as provided for herein.

The terms "year" and "fiscal year" shall mean the District's fiscal year, which initially shall be the twelve month period ending on September 30, but which subsequently may be any other 12 month period hereafter established by the District as a fiscal year for the purposes of the Contract and any resolution authorizing the Bonds.

Section 9. PLEDGE. (a) The Series 2014 Bonds and the interest thereon, are and shall be secured equally and ratably, on a parity, by and payable from a first lien on and pledge of the Gross Revenues; and the Series 2014 Bonds are Additional Bonds payable from and secured by, on a parity with all outstanding Bonds, a first lien on and pledge of the Gross Revenues, as permitted by Section 19 of the Series 2012 Bond Resolution.

(b) It is specifically recognized that the City is required to make Dallas Bond Payments from the gross revenues of its combined waterworks and sewer system, to the Issuer pursuant to the Contract sufficient to enable the Issuer to make all deposits and payments provided for herein, and that the Bonds, and the interest thereon, are and shall be payable from and secured by a first lien on and pledge of all of the Gross Revenues, and said Gross Revenues are further pledged irrevocably to the establishment and maintenance of the Funds hereinafter created.

(c) Chapter 1208, Government Code, applies to the issuance of the Bonds and the pledge of the Gross Revenues granted by the Issuer under this Section, and is therefore valid, effective, and perfected. Should Texas law be amended at any time while the Bonds are outstanding and unpaid, the result of such amendment being that the pledge of the revenues granted by the Issuer under this Section is to be subject to the filing requirements of Chapter 9, Business & Commerce Code, in order to preserve to the registered owners of the Bonds a security interest in said pledge, the Issuer agrees to take such measures as it determines are reasonable and necessary under Texas law to comply with the applicable provisions of Chapter 9, Business & Commerce Code and enable a filing of a security interest in said pledge to occur.

Section 10. SPECIAL FUNDS. All Gross Revenues shall be accounted for separate and apart from all other funds of the Issuer, and the following special Funds created and established by the Series 2012 Bond Resolution are hereby confirmed and shall be and maintained on the books of the Issuer, so long as any of the Bonds, or interest thereon, are outstanding and unpaid:

(a) the Revenue Fund;

(b) the Interest and Redemption Fund; and

(c) the Reserve Fund.

Section 11. REVENUE FUND. All Gross Revenues shall be credited as received by the Issuer to the Revenue Fund, and shall be deposited from the Revenue Fund into the Interest and Redemption Fund and the Reserve Fund in the manner and amounts hereinafter provided.

Section 12. INTEREST AND REDEMPTION FUND. (a) There shall be deposited into the Interest and Redemption Fund the following:

(i) immediately after the delivery of the Bonds all accrued interest, if any, from the proceeds from the sale of the Bonds;

(ii) on or before each interest payment date on the Bonds, an amount sufficient, together with other amounts, if any, on hand therein, to pay the interest coming due on the Bonds on each such interest payment date;

(iii) on or before each principal payment date on the Bonds, an amount sufficient, together with other amounts, if any, on hand therein, to pay the principal coming due on the Bonds on each such principal payment date; and

(iv) on or before each redemption date for the Bonds, an amount sufficient, together with other amounts, if any, on hand therein, to pay the redemption price, including interest accrued, on Bonds called for redemption on such redemption date.

(b) The Interest and Redemption Fund shall be used solely to pay the principal of and interest on the Bonds when due, whether upon scheduled payment dates or upon earlier redemption.

Section 13. RESERVE FUND. Subject to the provisions of Section 28 of this Resolution, the Issuer shall maintain in the Reserve Fund an amount not less in market value than the average annual principal and interest requirements on all Bonds outstanding (the "Required Reserve") as of the date of any computation thereof. Immediately after the delivery of the Initial Bond, the Issuer shall cause to be deposited from the proceeds from the sale and delivery of the Initial Bond into the Reserve Fund an amount sufficient to cause the Reserve Fund to have on deposit an amount equal to the Required Reserve.

The Reserve Fund shall be used to pay the principal of or interest on the Bonds, at any time when there is not sufficient money available in the Interest and Redemption Fund for such purpose, or to pay the principal of or interest on the last maturing Bonds.

For the purpose of determining the amount on deposit to the credit of the Reserve Fund investments in which money in such account shall have been invested shall be computed at the market value of such investment. The amount on deposit to the credit of the Reserve Fund shall be computed by the Issuer at least annually, and shall be computed immediately upon any withdrawal from the Reserve Fund. The Issuer may at any time substitute a Credit Facility for all or part of the cash or other Credit Facility on deposit in, or held for the benefit of, the Reserve Fund. The amount of a Credit Facility shall be the remaining amount or remaining coverage amount thereof.

When and so long as the money and investments and/or coverage afforded by a Credit Facility in the Reserve Fund total not less than the Required Reserve, no deposits need be made to the credit of the Reserve Fund; but when and if the Reserve Fund at any time contains less than the Required Reserve, the Issuer covenants and agrees to require the City to cure the deficiency in the Required Reserve pursuant to the Contract within twelve (12) months from the date the deficiency in funds occurred. So long as the Reserve Fund contains the Required Reserve in market value, all amounts in excess of Required Reserve, if any, shall, at least annually, on or before the 25th day of August of each year, be deposited to the credit of the Interest and Redemption Fund.

Section 14. PROJECT CONSTRUCTION FUND. There shall be established a Project Construction Fund with the Issuer's depository bank and upon the delivery of each series of Bonds, the net proceeds of such Bonds, after making any required deposits to the Interest and Redemption Fund and the Reserve Fund for such Bonds, shall be deposited into the Project Construction Fund. Money in the Project Construction Fund shall be subject to disbursements by the Issuer for payment of all costs incurred in carrying out the purposes for which the Bonds are issued.

Section 15. INVESTMENTS. Money in any Fund maintained pursuant to this Resolution or any resolution authorizing Additional Bonds may, at the option of the Issuer, be invested in any or all of the authorized investments described in the Public Funds Investment Act, Chapter 2256, Texas Government Code (or any successor statute), in which the Issuer may purchase, sell and invest its funds and funds under its control. Such deposits and investments shall be made consistent with the estimated requirements of such Funds, and any obligation in which money is so invested shall be kept and held at the bank at which the Fund is maintained for the benefit of the owners of the Bonds, and shall be promptly sold and the proceeds of sale applied to the making of all payments required to be made from the Fund from which the investment was made. All earnings from the deposit or investment of any such Fund shall be credited to such Fund. All investment earnings on deposit in the Interest and Redemption Fund shall reduce the amounts which otherwise would be required to be deposited therein, with the result that the City's principal and/or interest payments under the Contract shall be reduced accordingly.

Section 16. DEFICIENCIES OR SURPLUSES IN FUNDS. (a) If the Issuer should fail at any time to deposit into the Interest and Redemption Fund and the Reserve Fund created by this Resolution or any resolution authorizing Additional Bonds the full amounts required, amounts equivalent to such deficiencies shall be set apart and paid into said Funds from the first available Gross Revenues, and such payments shall be in addition to the amounts otherwise required to be deposited into said Funds.

(b) Subject to making the required deposits to the Interest and Redemption Fund and the Reserve Fund when and as required by this Resolution, excess Gross Revenues may be used by the Issuer for any lawful purpose related to the Dallas Project Component of the Project.

Section 17. ISSUER'S EXPENSES. The Gross Revenues in excess of those necessary to establish and maintain the Funds as required in this Resolution, or as hereafter may be required in connection with the issuance of Additional Bonds, shall be used by the Issuer to pay its expenses attributable to the Bonds and the Project, including the fees and charges of the Paying Agent/Registrar, all to the extent provided in the Contract.

Section 18. SECURITY FOR FUNDS. All Funds created by this Resolution or any resolution authorizing Additional Bonds shall be secured in the manner prescribed by law, including particularly, the Public Funds Collateral Act, Chapter 2257, Texas Government Code, for the security of public funds, and such Funds shall be used only for the purposes and in the manner permitted or required by this Resolution.

Section 19. ADDITIONAL BONDS. The Issuer reserves the right to issue additional parity revenue bonds ("Additional Bonds") for the purpose of completing the acquisition, by purchase and construction, of the Project in accordance with the Contract, and/or for the purpose of refunding any of the Bonds. Such Additional Bonds shall be considered, constitute, and be defined as "Bonds", for all purposes of this Resolution and the Contract, and when issued and delivered, they shall be payable from and secured by a first lien on and pledge of the Gross Revenues, in the same manner and to the same extent as the other Bonds; and all of the Bonds shall in all respects be on a parity and of equal dignity. The Additional Bonds may be issued in one or more installments or series, provided, however, that no such installment or series shall be issued unless:

(a) a certificate is executed by the President and Secretary of the Board of Directors of the Issuer to the effect that no default exists in connection with the Contract or any of the covenants or requirements of the resolution or resolutions authorizing the issuance of all then outstanding Bonds, and that the Reserve Fund contains the amount then required to be on deposit therein.

(b) the resolution authorizing the issuance of such installment or series of Additional Bonds shall provide for the payment of the principal of and interest on such Additional Bonds and shall confirm the Reserve Fund, as additional security for all such Additional Bonds, and the Reserve Fund shall be increased to the extent required to cause the Reserve Fund to be maintained in an amount not less than the Required Reserve after the issuance of such then proposed Additional Bonds (or any greater amount as may, at the option of the Issuer, be provided for in any resolution authorizing the issuance of any Additional Bonds), and shall make provision for funding such Reserve Fund from Gross Revenues, or, at the option of the Issuer, from proceeds of such Additional Bonds or other available sources. The Reserve Fund may be funded in whole or in part initially, or may be funded in whole or in part from Gross Revenues by approximately equal periodic payments, not less than annual, and within not more than five years from the date of such then proposed Additional Bonds.

All calculations of principal and interest requirements of any Bonds made in connection with the issuance of any then proposed Additional Bonds shall be made as of the date of such Additional Bonds, and also in making calculations for such purpose, or for any other purpose under any

resolution authorizing any Bonds, the principal amounts of any Bonds which must be redeemed prior to maturity pursuant to any applicable mandatory redemption requirements hall be deemed to be maturing amounts of principal.

Section 20. ACCOUNTS AND RECORDS. The Issuer shall keep proper books of records and accounts, separate from all other records and accounts of the Issuer, in which complete and correct entries shall be made of all transactions relating to the Contract. The Issuer shall have said books audited once each Issuer fiscal year by a Certified Public Accountant.

Section 21. ACCOUNTING REPORTS. Within one hundred fifty days after the close of each Issuer fiscal year hereafter, the Issuer will furnish, without cost, to any owner of at least twenty-five percent (25%) of any outstanding Bonds who may so request, a signed or certified copy of a report by a Certified Public Accountant covering such fiscal year, showing the following information:

(a) A detailed statement of all Gross Revenues;

(b) Balance sheet as of the end of said fiscal year;

(c) Accountant's comment regarding the manner in which the Issuer has complied with the requirements of this Resolution and his recommendations, if any, for any changes or improvements.

Section 22. INSPECTION. Any owner or owners of any Bonds shall have the right at all reasonable times to inspect all records, accounts, and data of the Issuer relating to the Contract and the Funds created by this Resolution.

Section 23. SPECIAL COVENANTS. The Issuer further covenants as follows:

(a) that other than for the payment of the Bonds, the Gross Revenues have not in any manner been pledged to the payment of any debt or obligation of the Issuer.

(b) that while any of the Bonds are outstanding, the Issuer will not, with the exception of the Additional Bonds expressly permitted by this Resolution to be issued, additionally encumber the Gross Revenues, unless said encumbrance is made junior and subordinate in all respects to the liens, pledges, covenants, and agreements of each resolution authorizing the issuance of the Bonds, but the right of the Issuer to issue obligations for any lawful purpose payable from a subordinate lien on the Gross Revenues is specifically recognized and retained.

(c) that the Issuer will carry out all of its obligations under the Contract; and when or if necessary will promptly enforce and cause the City to carry out all of its obligations under the Contract, for the benefit of the Issuer and the owners of the Bonds, by all legal and equitable means, including the use of mandamus proceedings against the City.

Section 24. BONDS ARE SPECIAL OBLIGATIONS. The Bonds shall be special obligations of the Issuer payable from the pledged Gross Revenues, and the registered owner or

owners of the Bonds shall never have the right to demand payment thereof from any source other than as provided for in the Contract and this Bond Resolution. The Issuer is not authorized to, and shall not levy, collect, or use any tax of any nature to pay the principal of or interest on any of the Bonds.

Section 25. AMENDMENT OF RESOLUTION. (a) The holders or owners of Bonds aggregating at least a majority in principal amount of the aggregate principal amount of then outstanding Bonds shall have the right to approve any amendment to any resolution authorizing the issuance of Bonds, which may be deemed necessary or desirable by the Issuer, provided, however, that nothing herein contained shall permit or be construed to permit the amendment of the terms and conditions in said resolutions or in the Bonds so as to:

(1) Make any change in the maturity of the outstanding Bonds;

(2) Reduce the rate of interest borne by any of the outstanding Bonds;

(3) Reduce the amount of the principal payable on the outstanding Bonds;

(4) Modify the terms of payment of principal of or interest on the outstanding Bonds, or impose any conditions with respect to such payment;

(5) Affect the rights of the holders of less than all of the Bonds then outstanding;

(6) Change the minimum percentage of the principal amount of Bonds necessary for consent to such amendment.

(b) If at any time the Issuer shall desire to amend a resolution under this Section, the Issuer shall cause notice of the proposed amendment to be published in a financial newspaper or journal published in the City of New York, New York, or in the City of Austin, Texas, once during each calendar week for at least two successive calendar weeks. Such notice shall briefly set forth the nature of the proposed amendment and shall state that a copy thereof is on file at the principal office of each Paying Agent/Registrar of any Bonds for inspection by all owners of Bonds. Such publication is not required, however, if notice in writing is given to each owner of Bonds.

(c) Whenever at any time not less than thirty days, and within one year, from the date of the first publication of notice or other service of written notice the Issuer shall receive an instrument or instruments executed by the owners of at least a majority in aggregate principal amount of all Bonds and then outstanding, which instrument or instruments shall refer to the proposed amendment described in said notice and which specifically consent to and approve such amendment in substantially the form of the copy thereof on file as aforesaid, the Issuer may adopt the amendatory resolution in substantially the same form.

(d) Upon the adoption of any amendatory resolution pursuant to the provisions of this Section, the resolution being amended shall be deemed to be amended in accordance with the amendatory resolution, and the respective rights, duties, and obligations of the Issuer and all the holders or owners of then outstanding Bonds and all future Bonds shall thereafter be determined, exercised, and enforced hereunder, subject in all respects to such amendment.

(e) Any consent given by the owner of a Bond pursuant to the provisions of this Section shall be irrevocable for a period of six months from the date of the first publication of the notice provided for in this Section, and shall be conclusive and binding upon all future owners of the same Bond during such period. Such consent may be revoked at any time after six months from the date of the first publication of such notice by the owner who gave such consent, or by a successor in title, by filing notice thereof with the Paying Agent/Registrar for such Bond, and the Issuer, but such revocation shall not be effective if the owners of at least a majority in aggregate principal amount of the then outstanding Bonds as in this Section defined have, prior to the attempted revocation, consented to and approved the amendment.

(f) For the purpose of this Section, the ownership of any Bond shall be ascertained by the registration books pertaining thereto kept by the Paying Agent/Registrar therefor. The Issuer may conclusively assume that such holding or ownership continues until written notice to the contrary is served upon the Issuer.

Section 26. DEFEASANCE OF BONDS. (a) The Bonds and the interest thereon shall be deemed to be paid, retired, and no longer outstanding (a "Defeased Bond") within the meaning of this Resolution, except to the extent provided in subsection (d) of this Section, when payment of the principal of such Bond, plus interest thereon to the due date (whether such due date be by reason of maturity, upon redemption, or otherwise) either (i) shall have been made or caused to be made in accordance with the terms thereof (including the giving of any required notice of redemption), or (ii) shall have been provided for on or before such due date by irrevocably depositing with or making available to the Paying Agent/Registrar for such payment (1) lawful money of the United States of America sufficient to make such payment or (2) Government Obligations which mature as to principal and interest in such amounts and at such times as will insure the availability, without reinvestment, of sufficient money to provide for such payment, and when proper arrangements have been made by the Issuer with the Paying Agent/Registrar for the payment of its services until all Defeased Bonds shall have become due and payable. At such time as a Bond shall be deemed to be a Defeased Bond hereunder, as aforesaid, such Bond and the interest thereon shall no longer be secured by, payable from, or entitled to the benefits of, the Gross Revenues as provided in this Resolution, and such principal and interest shall be payable solely from such money or Government Obligations.

(b) Any moneys so deposited with the Paying Agent/Registrar may at the written direction of the Issuer also be invested in Government Obligations, maturing in the amounts and times as hereinbefore set forth, and all income from such Government Obligations received by the Paying Agent/Registrar which is not required for the payment of the Bonds and interest thereon, with respect to which such money has been so deposited, shall be turned over to the Issuer, or deposited as directed in writing by the Issuer.

(c) The term "Government Obligations" as used in this Section shall mean (i) direct, noncallable obligations of the United States of America, including obligations that are unconditionally guaranteed by the United States of America, (ii) noncallable obligations of an agency or instrumentality of the United States of America, including obligations that are unconditionally guaranteed or insured by the agency or instrumentality and that, on the date the Board of Directors adopts or approves proceedings authorizing the issuance of refunding bonds or otherwise provide for the funding of an escrow to effect the defeasance of the Bonds, are rated as

to investment quality by a nationally recognized investment rating firm not less than "AAA" or its equivalent, and (iii) noncallable obligations of a state or an agency or a county, municipality, or other political subdivision of a state that have been refunded and that, on the date the Board of Directors adopts or approves proceedings authorizing the issuance of refunding bonds or otherwise provide for the funding of an escrow to effect the defeasance of the Bonds, are rated as to investment quality by a nationally recognized investment rating firm no less than "AAA" or its equivalent.

(d) Until all Defeased Bonds shall have become due and payable, the Paying Agent/Registrar shall perform the services of Paying Agent/Registrar for such Defeased Bonds the same as if they had not been defeased, and the Issuer shall make proper arrangements to provide and pay for such services as required by this Resolution.

Section 27. DAMAGED, MUTILATED, LOST, STOLEN, OR DESTROYED BONDS. (a) Replacement Bonds. In the event any outstanding Bond is damaged, mutilated, lost, stolen, or destroyed, the Paying Agent/Registrar shall cause to be printed, executed, and delivered, a new bond of the same principal amount, maturity, and interest rate, as the damaged, mutilated, lost, stolen, or destroyed Bond, in replacement for such Bond in the manner hereinafter provided.

(b) Application for Replacement Bonds. Application for replacement of damaged, mutilated, lost, stolen, or destroyed Bonds shall be made by the registered owner thereof to the Paying Agent/Registrar. In every case of loss, theft, or destruction of a Bond, the registered owner applying for a replacement bond shall furnish to the Issuer and to the Paying Agent/Registrar such security or indemnity as may be required by them to save each of them harmless from any loss or damage with respect thereto. Also, in every case of loss, theft, or destruction of a Bond, the registered owner shall furnish to the Issuer and to the Paying Agent/Registrar evidence to their satisfaction of the loss, theft, or destruction of such Bond, as the case may be. In every case of damage or mutilation of a Bond, the registered owner shall surrender to the Paying Agent/Registrar for cancellation the Bond so damaged or mutilated.

(c) No Default Occurred. Notwithstanding the foregoing provisions of this Section, in the event any such Bond shall have matured, and no default has occurred which is then continuing in the payment of the principal of, redemption premium, if any, or interest on the Bond, the Issuer may authorize the payment of the same (without surrender thereof except in the case of a damaged or mutilated Bond) instead of issuing a replacement Bond, provided security or indemnity is furnished as above provided in this Section.

(d) Charge for Issuing Replacement Bonds. Prior to the issuance of any replacement bond, the Paying Agent/Registrar shall charge the registered owner of such Bond with all legal, printing, and other expenses in connection therewith. Every replacement bond issued pursuant to the provisions of this Section by virtue of the fact that any Bond is lost, stolen, or destroyed shall constitute a contractual obligation of the Issuer whether or not the lost, stolen, or destroyed Bond shall be found at any time, or be enforceable by anyone, and shall be entitled to all the benefits of this Resolution equally and proportionately with any and all other Bonds duly issued under this Resolution.

(e) Authority for Issuing Replacement Bonds. In accordance with Chapter 1201, Texas Government Code, this Section of this Resolution shall constitute authority for the issuance of any

such replacement bond without necessity of further action by the governing body of the Issuer or any other body or person, and the duty of the replacement of such bonds is hereby authorized and imposed upon the Paying Agent/Registrar, and the Paying Agent/Registrar shall authenticate and deliver such Bonds in the form and manner and with the effect, as provided in Section 6(d) of this Resolution for Bonds issued in conversion and exchange for other Bonds.

Section 28. COVENANTS REGARDING TAX-EXEMPTION. (a) Covenant. The Issuer covenants to refrain from any action which would adversely affect, or to take such action to assure, the treatment of the Series 2014 Bonds as obligations described in section 103 of the Code, the interest on which is not includable in the "gross income" of the holder for purposes of federal income taxation. In furtherance thereof, the Issuer covenants as follows:

(1) to take any action to assure that no more than 10 percent of the proceeds of the Series 2014 Bonds or the projects financed therewith (less amounts deposited into a reserve fund, if any) are used for any "private business use," as defined in section 141(b)(6) of the Code, or if more than 10 percent of the proceeds or the projects financed therewith are so used, such amounts, whether or not received by the Issuer, with respect to such private business use, do not, under the terms of this Resolution or any underlying arrangement, directly or indirectly, secure or provide for the payment of more than 10 percent of the debt service on the Series 2014 Bonds, in contravention of section 141(b)(2) of the Code;

(2) to take any action to assure that in the event that the "private business use" described in subsection (a) hereof exceeds five percent of the proceeds of the Series 2014 Bonds or the projects financed therewith (less amounts deposited into a reserve fund, if any) then the amount in excess of five percent is used for a "private business use" which is "related" and not "disproportionate," within the meaning of section 141(b)(3) of the Code, to the governmental use;

(3) to take any action to assure that no amount which is greater than the lesser of $5,000,000, or five percent of the proceeds of the Series 2014 Bonds (less amounts deposited into a reserve fund, if any) is, directly or indirectly, used to finance loans to persons, other than state or local governmental units, in contravention of section 141(c) of the Code;

(4) to refrain from taking any action that would otherwise result in the Series 2014 Bonds being treated as "private activity bonds" within the meaning of section 141(b) of the Code;

(5) to refrain from taking any action that would result in the Series 2014 Bonds being "federally guaranteed" within the meaning of section 149(b) of the Code;

(6) to refrain from using any portion of the proceeds of the Series 2014 Bonds, directly or indirectly, to acquire or to replace funds which were used, directly or indirectly, to acquire investment property (as defined in section 148(b)(2) of the Code) which produces a materially higher yield over the term of the Series 2014 Bonds, other than investment property acquired with --

(A) proceeds of the Series 2014 Bonds invested for a reasonable temporary period of 3 years or less or, in the case of a refunding bond, for a period of 30 days or less until such proceeds are needed for the purpose for which the Series 2014 Bonds are issued,

(B) amounts invested in a bona fide debt service fund, within the meaning of section 1.148-1(b) of the Treasury Regulations, and

(C) amounts deposited in any reasonably required reserve or replacement fund to the extent such amounts do not exceed 10 percent of the stated principal amount (or, in the case of a discount, the issue price) of the Series 2014 Bonds;

(7) to otherwise restrict the use of the proceeds of the Series 2014 Bonds or amounts treated as proceeds of the Series 2014 Bonds, as may be necessary, so that the Series 2014 Bonds do not otherwise contravene the requirements of section 148 of the Code (relating to arbitrage), section 149(g) of the Code (relating to hedge bonds), and, to the extent applicable, section 149(d) of the Code (relating to advance refundings); and

(8) to pay to the United States of America at least once during each five-year period (beginning on the date of delivery of the Series 2014 Bonds) an amount that is at least equal to 90 percent of the "Excess Earnings," within the meaning of section 148(f) of the Code and to pay to the United States of America, not later than 60 days after the Series 2014 Bonds have been paid in full, 100 percent of the amount then required to be paid as a result of Excess Earnings under section 148(f) of the Code.

(b) Rebate Fund. In order to facilitate compliance with the above covenant (a)(8), a "Rebate Fund" is hereby established by the Issuer for the sole benefit of the United States of America, and such fund shall not be subject to the claim of any other person, including without limitation, the bondholders. The Rebate Fund is established for the additional purpose of compliance with section 148 of the Code.

(c) Compliance with Code. For purposes of the foregoing (a)(1) and (a)(2), the Issuer understands that the term "proceeds" includes "disposition proceeds" as defined in the Treasury Regulations. It is the understanding of the Issuer that the covenants contained herein are intended to assure compliance with the Code and any regulations or rulings promulgated by the U.S. Department of the Treasury pursuant thereto. In the event that regulations or rulings are hereafter promulgated which modify or expand provisions of the Code, as applicable to the Series 2014 Bonds, the Issuer will not be required to comply with any covenant contained herein to the extent that such failure to comply, in the opinion of nationally-recognized bond counsel, will not adversely affect the exemption from federal income taxation of interest on the Series 2014 Bonds under section 103 of the Code. In the event that regulations or rulings are hereafter promulgated which impose additional requirements which are applicable to the Series 2014 Bonds, the Issuer agrees to comply with the additional requirements to the extent necessary, in the opinion of nationally-recognized bond counsel, to preserve the exemption from federal income taxation of interest on the Series 2014 Bonds under section 103 of the Code. In furtherance of such intention, the Issuer hereby authorizes and directs its President or General Manager to execute any documents, certificates or reports required by the Code and to make such elections, on behalf of the Issuer,

which may be permitted by the Code as are consistent with the purpose for the issuance of the Series 2014 Bonds. The Issuer covenants to comply with the covenants contained in this Section after defeasance of the Series 2014 Bonds.

(d) Written Procedures. Unless superseded by another action of the Issuer to ensure compliance with the covenants contained herein regarding private business use, remedial actions, arbitrage and rebate, the Issuer hereby adopts and establishes the instructions attached hereto as Exhibit A as their written procedures applicable to Bonds issued pursuant to the Contract.

Section 29. ALLOCATION OF, AND LIMITATION ON, EXPENDITURES FOR THE PROJECT. The Issuer covenants to account for the expenditure of sale proceeds and investment earnings to be used for the Project on its books and records by allocating proceeds to expenditures within 18 months of the later of the date that (1) the expenditure is made, or (2) the Project is completed. The foregoing notwithstanding, the Issuer shall not expend sale proceeds or investment earnings thereon more than 60 days after the later of (1) the fifth anniversary of the delivery of the Series 2014 Bonds, or (2) the date the Series 2014 Bonds are retired, unless the Issuer obtains an opinion of nationally-recognized bond counsel that such expenditure will not adversely affect the tax-exempt status of the Series 2014 Bonds. For purposes hereof, the Issuer shall not be obligated to comply with this covenant if it obtains an opinion that such failure to comply will not adversely affect the excludability for federal income tax purposes from gross income of the interest.

Section 30. DISPOSITION OF PROJECT. The Issuer covenants that the property constituting the Project will not be sold or otherwise disposed in a transaction resulting in the receipt by the Issuer of cash or other compensation, unless the Issuer obtains an opinion of nationally-recognized bond counsel that such sale or other disposition will not adversely affect the tax-exempt status of the Bonds. For purposes of the foregoing, the portion of the property comprising personal property and disposed in the ordinary course shall not be treated as a transaction resulting in the receipt of cash or other compensation. For purposes hereof, the Issuer shall not be obligated to comply with this covenant if it obtains an opinion that such failure to comply will not adversely affect the excludability for federal income tax purposes from gross income of the interest.

Section 31. CUSTODY, APPROVAL, AND REGISTRATION OF INITIAL BOND; CO-BOND COUNSEL'S OPINION, CUSIP NUMBERS, INSURANCE, AND PREAMBLE. The President of the Board of Directors of the Issuer is hereby authorized to have control of the Initial Bond issued hereunder and all necessary records and proceedings pertaining to the Initial Bond pending its delivery and its investigation, examination, and approval by the Attorney General of the State of Texas, and its registration by the Comptroller of Public Accounts of the State of Texas. Upon registration of the Initial Bond said Comptroller of Public Accounts (or a deputy designated in writing to act for said Comptroller) shall manually sign the Comptroller's Registration Certificate on the Initial Bond, and the seal of said Comptroller shall be impressed, or placed in facsimile, on the Initial Bond. The approving legal opinion of the Issuer's Co-Bond Counsel and the assigned CUSIP numbers may, at the option of the Issuer, be printed on the Initial Bond or on any Series 2014 Bonds issued and delivered in conversion of and exchange or replacement of any Series 2014 Bond, but neither shall have any legal effect, and shall be solely for the convenience and information of the registered owners of the Series 2014 Bonds. If insurance is obtained by the Underwriters (as defined in Section 33 hereof) on any of the Series 2014 Bonds, the Initial Bond and such Series 2014

Bonds may bear an appropriate legend concerning insurance as provided by the insurer. The preamble to this Resolution is hereby adopted and made a part hereof for all purposes.

Section 32. INTEREST EARNINGS ON SERIES 2014 BOND PROCEEDS. Interest earnings derived from the investment of proceeds from the sale of the Series 2014 Bonds shall be used along with other bond proceeds for the acquisition and construction of the Project in accordance with the Contract; provided that after completion of the Project, if any of such interest earnings remain on hand, such interest earnings along with any surplus bond proceeds shall be deposited in the Interest and Redemption Fund. It is further provided, however, that any interest earnings on bond proceeds which are required to be rebated to the United States of America pursuant to this Resolution in order to prevent the Series 2014 Bonds from being arbitrage bonds shall be so rebated and not considered as interest earnings for the purposes of this Section.

Section 33. SALE OF SERIES 2014 BONDS. Pursuant to the authorizations in Section 3 hereof, as approved by the Authorized Officer, the Series 2014 Bonds may be sold either pursuant to the taking of bids therefor as provided in the Official Notice of Sale or pursuant to a purchase agreement (the "Purchase Agreement") with a purchaser or purchasers (collectively, the "Underwriters") to be approved by the Authorized Officer, and any supplements thereto which may be necessary to accomplish the issuance of Bonds. Such Purchase Agreement is hereby authorized to be dated, executed and delivered on behalf of the Issuer by an Authorized Officer, with such changes therein as shall be approved by the Authorized Officer, the execution thereof by the Authorized Officer to constitute evidence of such approval. The delegation of authority to the Authorized Officer to approve the final terms of the Series 2014 Bonds as set forth in this Resolution is, and the decisions made by the Authorized Officer pursuant to such delegated authority will be, in the best interests of the Issuer, and the Authorized Officer is authorized to make a finding to such effect in the Approval Certificate.

Section 34. APPROVAL OF OFFICIAL STATEMENT. A Preliminary Official Statement relating to the Series 2014 Bonds, in substantially the form as submitted to the Board of Directors at this meeting, is hereby approved and authorized to be distributed to prospective investors and other interested parties in connection with the underwriting and sale of the Series 2014 Bonds, with such changes therein as shall be approved by the President of the Board of Directors or the General Manager of the Issuer, including such changes as are necessary for distribution as a final Official Statement. It is further officially found, determined, and declared that the statements and representations contained in said Preliminary Official Statement are true and correct in all material respects. The use and distribution by the Underwriters of the Official Statement relating to the Series 2014 Bonds, is hereby approved. For the purpose of review by the Underwriters prior to purchasing the Series 2014 Bonds, the Issuer deems said Preliminary Official Statement to have been "final as of its date" within the meaning of United States Securities and Exchange Commission Rule 15c2-12.

Section 35. ATTORNEY GENERAL FEES. The Issuer hereby authorizes and directs payment, from legally available funds of the Issuer, of the nonrefundable examination fee of the Attorney General of the State of Texas required by Section 1202.004, Texas Government Code, as amended.

Section 36. FURTHER PROCEDURES. The President and the Secretary of the Board of Directors and the General Manager and the Finance Director of the Issuer, and all other officers, employees, and agents of the Issuer, and each of them, shall be and they are hereby expressly authorized, empowered, and directed from time to time and at any time to do and perform all such acts and things and to execute, acknowledge, and deliver in the name and on behalf of the Issuer all such instruments, whether or not herein mentioned, as may be necessary or desirable in order to carry out the terms and provisions of this Resolution, and all details in connection therewith. In case any officer whose signature shall appear on any Series 2014 Bond shall cease to be such officer before the delivery of such Series 2014 Bond, such signature shall nevertheless be valid and sufficient for all purposes the same as if such officer had remained in office until such delivery.

Section 37. CONTINUING DISCLOSURE UNDERTAKING.

(a) Annual Reports.

The Issuer shall provide or cause the City to provide annually to the MSRB, within six months after the end of each fiscal year of the City ending in or after 2014, financial information and operating data (i) of the general type included in the final Official Statement authorized by Section 34 of this Resolution, being the information described in Exhibit B hereto. Any financial information so to be provided shall be (1) prepared in accordance with the accounting principles described in Exhibit B hereto, or such other accounting principles as the City may be required to employ from time to time pursuant to state law or regulation, and (2) audited, if the City commissions an audit of such statements and the audit is completed within the period during which they must be provided. If the audit of such financial statements of the City are not complete within such period, then the Issuer shall provide or cause the City to provide unaudited financial information and operating data which is customarily prepared by the City by the required time to the MSRB, and will provide audited information when and if the audit report becomes available.

If the City changes its fiscal year, the Issuer will notify or cause the City to notify the MSRB the change (and of the date of the new fiscal year end) prior to the next date by which the Issuer or the City otherwise would be required to provide financial information and operating data pursuant to this Section.

The financial information and operating date to be provided pursuant to this Section may be set forth in full in one or more documents or may be included by specific reference to any document (including an official statement or other offering document, if it is available from the MSRB) that theretofore has been provided to the MSRB or filed with the SEC.

(b) Disclosure Event Notices.

The Issuer shall notify or cause the City to notify the MSRB, in a timely manner, of any of the following events with respect to the Series 2014 Bonds, not in excess of ten Business Days after occurrence of the event:

1. Principal and interest payment delinquencies;

2. Non-payment related defaults, if material;

3. Unscheduled draws on debt service reserves reflecting financial difficulties;

4. Unscheduled draws on credit enhancements reflecting financial difficulties;

5. Substitution of credit or liquidity providers, or their failure to perform;

6. Adverse tax opinions, the issuance by the Internal Revenue Service of proposed or final determinations of taxability, Notices of Proposed Issue (IRS Form 5701-TEB) or other material notices or determinations with respect to the tax status of the security, or other material events affecting the tax status of the security;

7. Modifications to the rights of security holders, if material;

8. Bond calls, if material, and tender offers;

9. Defeasances;

10. Release, substitution or sale of property securing repayment of the securities, if material;

11. Rating changes;

12. Bankruptcy, insolvency, receivership or similar event of the City;

13. The consummation of a merger, consolidation, or acquisition involving the City or the sale of all or substantially all of the assets of the City, other than in the ordinary course of business, the entry into a definitive agreement to undertake such an action or the termination of a definitive agreement relating to any such actions, other than pursuant to its terms, if material; and

14. Appointment of a successor or additional trustee or the change of name of a trustee, if material.

The Issuer shall notify or cause the City to notify the MSRB, in a timely manner, of any failure by the Issuer or the City to provide financial information or operating data in accordance with Section 37(a) of this Resolution by the time required by such Section. As used in clause 12 above, the phrase "bankruptcy, insolvency, receivership or similar event" means the appointment of a receiver, fiscal agent, or similar officer for the Issuer in a proceeding under the U.S. Bankruptcy Code or in any other proceeding under state or federal law in which a court or governmental authority has assumed jurisdiction over substantially all of the assets or business of the Issuer, or if jurisdiction has been assumed by leaving the Board of Directors and official or officers of the Issuer in possession but subject to the supervision and orders of a court or governmental authority, or the entry of an order confirming a plan of reorganization, arrangement or liquidation by a court or governmental authority having supervision or jurisdiction over substantially all of the assets or business of the Issuer.

(c) Limitations, Disclaimers, and Amendments.

The Issuer shall be obligated to observe and perform or cause the City to observe and perform the covenants specified in this Section, except that the Issuer in any event will give notice of any deposit made in accordance with Section 26 hereof that causes Series 2014 Bonds no longer to be Outstanding.

The provisions of this Section are for the sole benefit of the Holders and beneficial owners of the Series 2014 Bonds, and nothing in this Section, express or implied, shall give any benefit or any legal or equitable right, remedy, or claim hereunder to any other person. The Issuer undertakes to provide or cause the City to provide only the financial information, operating data, financial statements, and notices which it has expressly agreed to provide pursuant to this Section and does not hereby undertake to provide or cause to be provided any other information that may be relevant or material to a complete presentation of the City's financial results, condition or prospects or hereby undertake to update any information provided in accordance with this Section or otherwise, except as expressly provided herein. The Issuer does not make any representation or warranty concerning such information or its usefulness to a decision to invest in or sell Series 2014 Bonds at any future date.

UNDER NO CIRCUMSTANCES SHALL THE ISSUER BE LIABLE TO THE HOLDER OR BENEFICIAL OWNER OF ANY SERIES 2014 BOND OR ANY OTHER PERSON, IN CONTRACT OR TORT, FOR DAMAGES RESULTING IN WHOLE OR IN PART FROM ANY BREACH BY THE ISSUER, WHETHER NEGLIGENT OR WITHOUT FAULT ON ITS PART, OF ANY COVENANT SPECIFIED IN THIS SECTION, BUT VERY RIGHT AND REMEDY OF ANY SUCH PERSON, IN CONTRACT OR TORT, FOR OR ON ACCOUNT OF ANY SUCH BREACH SHALL BE LIMITED TO AN ACTION FOR MANDAMUS OR SPECIFIC PERFORMANCE.

No default by the Issuer in observing or performing its obligations under this Section shall comprise a breach of or default under this Resolution for purposes of any other provision of this Resolution.

Nothing in this Section is intended or shall act to disclaim, waive, or otherwise limit the duties of the Issuer under federal and state securities laws.

The provisions of this Section may be amended by the Issuer from time to time to adapt to changed circumstances that arise from a change in legal requirements, a change in law, or a change in the identify, nature, status, or type of operations of the City, but only if (1) the provisions of this Section, as so amended, would have permitted an underwriter to purchase or sell Series 2014 Bonds in the primary offering of the Series 2014 Bonds in compliance with the Rule, taking into account any amendments or interpretations of the Rule since such offering as well s such changed circumstances and (2) either (a) the Holders of a majority in aggregate principal amount (or any greater amount required by any other provision of this Resolution that authorizes such an amendment) of the outstanding Series 2014 Bonds consent to such amendment or (b) a Person that is unaffiliated with the Issuer (such as nationally recognized bond counsel) determined that such amendment will not materially impair the interest of the Holders and beneficial owners of the Series 2014 Bonds. If the Issuer so amends the provisions of this Section, it shall include, or cause the City to include, with any amended financial information or operating data next provided in accordance

with Subsection (a) hereof an explanation, in narrative form, of the reason for the amendment and of the impact of any change in the type of financial information or operating data so provided. The Issuer may also amend or repeal the provisions of this continuing disclosure agreement if the SEC amends or repeals the applicable provision of the Rule or a court of final jurisdiction enters judgment that such provisions of the Rule are invalid, but only if and to the extent that the provisions of this sentence would not prevent an underwriter from lawfully purchasing or selling Series 2014 Bonds in the primary offering of the Series 2014 Bonds.

(d) Definitions.

As used in this Section, the following terms have the meanings ascribed to such terms below:

"*MSRB*" means the Municipal Securities Rulemaking Board.

"*Rule*" means SEC Rule 15c2-12, as amended from time to time.

"*SEC*" means the United States Securities and Exchange Commission and any successor to its duties.

Section 38. REPEAL OF CONFLICTING RESOLUTIONS. All resolutions and all parts of any resolutions which are in conflict or inconsistent with this Resolution are hereby repealed and shall be of no further force or effect to the extent of such conflict or inconsistency.

Section 39. PUBLIC NOTICE. It is hereby officially found and determined that public notice of the time, place and purpose of said meeting was given, all as required by the Government Code, Chapter 551.

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EXHIBIT A

WRITTEN PROCEDURES RELATING TO CONTINUING
COMPLIANCE WITH FEDERAL TAX COVENANTS

A. Arbitrage. With respect to the investment and expenditure of the proceeds of the Bonds (the "Obligations") the Issuer's General Manager, Assistant General Manager, and Finance Director (the "Responsible Persons") will :

For Obligations issued for newly acquired property or constructed property:

- instruct the appropriate person or persons that the construction, renovation or acquisition of the facilities must proceed with due diligence and that binding contracts for the expenditure of at least 5%of the proceeds of the Obligations will be entered into within 6 months of the Issue Date;
- monitor that at least 85% of the proceeds of the Obligations to be used for the construction, renovation or acquisition of any facilities are expended within 3 years of the date of delivery of the Obligations ("Issue Date");
- restrict the yield of the investments (other than those in the Reserve Fund) to the yield on the Obligations after 3 years of the Issue Date;
- monitor all amounts deposited into a sinking fund or funds, e.g., the Interest and Redemption Fund and the Reserve Fund, to assure that the maximum amount invested at a yield higher than the yield on the Obligations does not exceed an amount equal to the debt service on the Obligations in the succeeding 12 month period plus a carryover amount equal to one-twelfth of the principal and interest payable on the Obligations for the immediately preceding 12-month period;
- assure that no more than 50% of the proceeds of the Obligations are invested in an investment with a guaranteed yield for 4 years or more;
- assure that the maximum amount of the Reserve Fund invested at a yield higher than the yield on the Obligations will not exceed the lesser of (1) 10% of the original principal amount of the Obligations, (2) 125% of the average annual debt service on the Obligations measured as of the Issue Date, or (3) 100% of the maximum annual debt service on the Obligations as of the Issue Date;

For Obligations issued for refunding purposes:

- monitor the actions of the escrow agent (to the extent an escrow is funded with proceeds) to assure compliance with the applicable provisions of the escrow agreement, including with respect to reinvestment of cash balances;

For all Obligations:

- maintain any official action of the Issuer (such as a reimbursement resolution) stating its intent to reimburse itself or the City with the proceeds of the Obligations any amount expended prior to the Issue Date for the acquisition, renovation or construction of the facilities;

- assure that the applicable information return (e.g., IRS Form 8038-G, 8038-GC, or any successor forms) is timely filed with the IRS;

- assure that, unless excepted from rebate and yield restriction under section 148(f) of the Code, excess investment earnings are computed and paid to the U.S. government at such time and in such manner as directed by the IRS (i) at least every 5 years after the Issue Date and (ii) within 30 days after the date the Obligations are retired.

B. Private Business Use. With respect to the use of the facilities financed or refinanced with the proceeds of the Obligations the Responsible Persons will:

- monitor the date on which the facilities are substantially complete and available to be used for the purpose intended;

- monitor whether, at any time the Obligations are outstanding, any person, other than the Issuer or the City, the employees of the Issuer or the City, the agents of the Issuer or the City or members of the general public has any contractual right (such as a lease, purchase, management or other service agreement) with respect to any portion of the facilities;

- monitor whether, at any time the Obligations are outstanding, any person, other than the Issuer or the City, the employees of the Issuer or the City, the agents of the Issuer or the City or members of the general public has a right to use the output of the facilities (e.g., water, gas, electricity);

- monitor whether, at any time the Obligations are outstanding, any person, other than the Issuer or the City, the employees of the Issuer or the City, the agents of the Issuer or the City or members of the general public has a right to use the facilities to conduct or to direct the conduct of research;

- determine whether, at any time the Obligations are outstanding, any person, other than the Issuer or the City, has a naming right for the facilities or any other contractual right granting an intangible benefit;

- determine whether, at any time the Obligations are outstanding, the facilities are sold or otherwise disposed of; and

- take such action as is necessary to remediate any failure to maintain compliance with the covenants contained in the resolution authorizing the Obligations.

C. Record Retention. The Responsible Persons will maintain or cause to be maintained all records relating to the investment and expenditure of the proceeds of the Obligations and the use of the facilities financed or refinanced thereby for a period ending three (3) years after the complete extinguishment of the Obligations. If any portion of the Obligations is refunded with the proceeds of another series of tax-exempt obligations, such records shall be maintained until the three (3) years after the refunding obligations are completely extinguished. Such records can be maintained in paper or electronic format.

D. Responsible Persons. Each Responsible Person shall receive appropriate training regarding the Issuer's accounting system, contract intake system, facilities management and other systems necessary to track the investment and expenditure of the proceeds and the use of the facilities financed with the proceeds of the Obligations. The foregoing notwithstanding, the Responsible Persons are authorized and instructed to retain such experienced advisors and agents as may be necessary to carry out the purposes of these instructions.

EXHIBIT B

DESCRIPTION OF ANNUAL FINANCIAL INFORMATION

The following information is referred to in Section 37 of this Resolution.

I. Annual Financial Statements and Operating Data

The financial information and operating data with respect to the Issuer to be provided annually in accordance with such Section are as specified (and included in the Appendix or under the headings of the Official Statement and Tables referred to) below:

Table 1 in the Official Statement

Tables 1 through 14 in Appendix B

Appendix C

Accounting Principles

The accounting principles referred to in such Section are the accounting principles described in the notes to the financial statements referred to in paragraph 1 above.

Part B #21

2014

CERTIFICATE FOR RESOLUTION

THE STATE OF TEXAS :
COUNTY OF TARRANT :
TARRANT REGIONAL WATER DISTRICT,
A WATER CONTROL AND IMPROVEMENT DISTRICT :

We, the undersigned officers of the Board of Directors of said District, hereby certify as follows:

1. The Board of Directors of said District convened in REGULAR MEETING ON THE 21ST OF JANUARY, 2014, at the regular designated meeting place, and the roll was called of the duly constituted officers and members of said Board, to-wit:

Victor W. Henderson, President
Jack R. Stevens, Vice President
Martha V. Leonard, Secretary
James W. Lane, Secretary Pro Tem
Mary Kelleher, Director

and all of said persons were present, except the following absentees: none, thus constituting a quorum. Whereupon, among other business, the following was transacted at said Meeting: a written

RESOLUTION AUTHORIZING THE ISSUANCE, SALE, AND DELIVERY OF TARRANT REGIONAL WATER DISTRICT, A WATER CONTROL AND IMPROVEMENT DISTRICT, WATER REVENUE BONDS, SERIES 2014, PLEDGING REVENUES FOR THE PAYMENT OF THE BONDS, APPROVING AN OFFICIAL STATEMENT, AND AUTHORIZING OTHER INSTRUMENTS AND PROCEDURES RELATING THERETO

was duly introduced for the consideration of said Board and read in full. It was then duly moved and seconded that said Resolution be passed; and, after due discussion, said motion, carrying with it the passage of said Resolution, prevailed and carried by the following vote:

AYES: All members of said Board shown present above voted "Aye"; except Kelleher.

NOES: 0.

ABSTENTION: 1

2. That a true, full, and correct copy of the aforesaid Resolution passed at the Meeting described in the above and foregoing paragraph is attached to and follows this Certificate; that said Resolution has been duly recorded in said Board's minutes of said Meeting; that the above and foregoing paragraph is a true, full, and correct excerpt from said Board's minutes of said Meeting pertaining to the passage of said Resolution; that the persons named in the above and foregoing paragraph are the duly chosen, qualified, and acting officers and members of said Board as indicated therein; that each of the officers and members of said Board was duly and sufficiently notified officially and personally, in advance, of the time, place, and purpose of the aforesaid Meeting, and that said Resolution would be introduced and considered for passage at said Meeting, and each of said officers and members consented, in advance, to the holding of said Meeting for such purpose; and that said Meeting was open to the public, and public notice of the time, place, and purpose of said Meeting was given all as required by Chapter 551, Texas Government Code.

SIGNED AND SEALED the 21st day of January, 2014.

Secretary, Board of Directors

President, Board of Directors

(SEAL)

RESOLUTION AUTHORIZING THE ISSUANCE, SALE, AND DELIVERY OF TARRANT REGIONAL WATER DISTRICT, A WATER CONTROL AND IMPROVEMENT DISTRICT, WATER REVENUE BONDS, SERIES 2014, PLEDGING REVENUES FOR THE PAYMENT OF THE BONDS, APPROVING AN OFFICIAL STATEMENT, AND AUTHORIZING OTHER INSTRUMENTS AND PROCEDURES RELATING THERETO

THE STATE OF TEXAS	§
COUNTY OF TARRANT	§
TARRANT REGIONAL WATER DISTRICT	
A WATER CONTROL AND IMPROVEMENT DISTRICT	§

WHEREAS, Tarrant Regional Water District, a Water Control and Improvement District, (formerly known as "Tarrant County Water Control and Improvement District Number One") (the "Issuer" or the "District") is a political subdivision of the State of Texas, being a conservation and reclamation district created and functioning under Article 16, Section 59, of the Texas Constitution, pursuant to the general laws of the State of Texas, including Chapters 49 and 51, Texas Water Code, and pursuant to the provisions of Chapter 268, Acts of 1957, 55th Legislature of Texas, Regular Session, as amended (collectively the "District Act"); and

WHEREAS, the Issuer will authorize the Series 2014 Bonds (hereinafter defined) pursuant to the District Act and Chapter 1371, Texas Govemment Code, as amended; and

WHEREAS, the meeting was open to the public and public notice of the time, place and purpose of said meeting was given pursuant to Chapter 551, Texas Government Code.

THEREFORE, BE IT RESOLVED BY THE BOARD OF DIRECTORS OF TARRANT REGIONAL WATER DISTRICT, A WATER CONTROL AND IMPROVEMENT DISTRICT, THAT:

Section 1. AMOUNT AND PURPOSE OF THE BONDS. The Bonds will be issued for the purpose of obtaining funds to pay for the planning, design, construction, and right of way costs related to the District's Water System, including additional water transmission and pumping facilities; development of new water resources, including costs related to the acquisition of out of state water and associated legal, engineering, and consulting costs; Cedar Creek Dam stabilization, pump station improvements, rebuilding Benbrook dechlorination facility, access bridges, monitoring equipment, generators, switches, instrumentation and other electrical equipment and improvements, and other construction, improvements, and repairs to the District's Water System; (ii) to fund a debt service reserve fund; and (iii) to pay costs of issuance of the Series 2014 Bonds.

Section 2. DESIGNATION OF THE BONDS. Each bond issued pursuant to this Resolution shall be designated: "TARRANT REGIONAL WATER DISTRICT, A WATER CONTROL AND IMPROVEMENT DISTRICT, WATER REVENUE BOND, SERIES 2014." Initially there shall be issued, sold, and delivered hereunder a single fully registered bond, without interest coupons, payable in installments of principal (the "Initial Bond"), but the Initial Bond may be assigned and transferred and/or converted into and exchanged for a like aggregate amount of fully

registered bonds, without interest coupons, having serial maturities, and in the denomination or denominations of $5,000 or any integral multiple of $5,000, all in the manner hereinafter provided. The term "Series 2014 Bonds" as used in this Resolution shall mean and include collectively the Initial Bond and all substitute bonds exchanged therefor, as well as all other substitute bonds and replacement bonds issued pursuant hereto, and the term "Series 2014 Bond" shall mean any of the Series 2014 Bonds.

Section 3. INITIAL DATE, DENOMINATION, NUMBER, MATURITIES, INITIAL REGISTERED OWNER, AND CHARACTERISTICS OF THE INITIAL BOND. (a) As authorized by Chapter 1371, Texas Government Code, as amended, the President of the Board of Directors, the General Manager, and the Finance Director of the Issuer are each hereby designated as an "Authorized Officer" of the Issuer, and each is hereby authorized, appointed, and designated as the officer or employee of the Issuer authorized to act on behalf of the Issuer, which actions shall be evidenced by a certificate executed by such Authorized Officer (the "Approval Certificate") for a period not to extend beyond June 1, 2014, in the selling and delivering of the Series 2014 Bonds and carrying out the other procedures specified in this Resolution, including the use of a book-entry only system with respect to the Series 2014 Bonds and the execution of an appropriate letter of representations if deemed appropriate, the determining and fixing of the date and the date of delivery of the Series 2014 Bonds, any additional or different designation or title by which the Bond shall be known, the price at which the Series 2014 Bonds will be sold (but in no event less than 97% of the principal amount of the Series 2014 Bonds), the principal amount (not exceeding $345,000,000) of the Series 2014 Bonds, the amount of each maturity of principal thereof, the due date of each such maturity (not exceeding forty years from the date of the Series 2014 Bonds), the rate of interest to be borne by each such maturity(but in no event to result in a net effective interest rate on the Series 2014 Bonds exceeding 5.25%), the interest payment dates and periods, the date or dates of optional redemption thereof, any mandatory sinking fund redemption provisions, procuring municipal bond insurance, if any, and approving modifications to this Resolution and executing such instruments, documents and agreements as may be necessary with respect thereto, and all other matters relating to the issuance, sale and delivery of the Series 2014 Bonds. It is further provided, however, that, notwithstanding the foregoing provisions, the Series 2014 Bonds shall not be delivered unless the Series 2014 Bonds are then rated by a nationally recognized rating agency in one of the four highest rating categories for a long-term instrument.

(b) The Initial Bond is hereby authorized to be issued, sold, and delivered hereunder as a single fully registered Bond, without interest coupons, in the denomination and aggregate principal amount set forth in the Approval Certificate (not exceeding $345,000,000), numbered TR-1, payable in annual installments of principal to the initial registered owner thereof or to the registered assignee or assignees of said Bond or any portion or portions thereof (in each case, the "registered owner"), with the annual installments of principal of the Initial Bond to be payable on the dates, respectively, and in the principal amounts, respectively, and may and shall be prepaid or redeemed prior to the respective scheduled due dates of installments of principal thereof, all as set forth in the Approval Certificate.

(c) The Initial Bond (i) if so provided in the Approval Certificate, may and/or shall be prepaid or paid on the respective scheduled due dates of installments of principal thereof, (ii) may be assigned and transferred, (iii) may be converted and exchanged for other bonds, (iv) shall have

the characteristics, and (v) shall be signed and sealed, and the principal of and interest on the Initial Bond shall be payable, all as provided, and in the manner required or indicated, in the FORM OF INITIAL BOND set forth in this Resolution.

Section 4. INTEREST. The unpaid principal balance of the Initial Bond shall bear interest from the date of delivery (the "Issue Date") of the Initial Bond to the Underwriters (as defined in Section 31 hereof) to the respective scheduled due dates, or to the respective dates of prepayment or redemption, if any, of the installments of principal of the Initial Bond, and such interest shall be payable in the manner, at the rates, and on the dates, respectively, as provided in the Approval Certificate and the FORM OF INITIAL BOND set forth in this Resolution.

Section 5. FORM OF INITIAL BOND. The form of the Initial Bond, including the form of Registration Certificate of the Comptroller of Public Accounts of the State of Texas to be endorsed on the Initial Bond, shall be substantially as follows, with blank or bracketed information to be completed or deleted based upon the Approval Certificate:

FORM OF INITIAL BOND

NO. TR-1 $_____*

UNITED STATES OF AMERICA
STATE OF TEXAS
TARRANT REGIONAL WATER DISTRICT,
A WATER CONTROL AND IMPROVEMENT DISTRICT,
WATER REVENUE BOND,
SERIES 2014

TARRANT REGIONAL WATER DISTRICT, A WATER CONTROL AND IMPROVEMENT DISTRICT (the "Issuer"), being a political subdivision of the State of Texas, hereby promises to pay to:

_____*

or to the registered assignee or assignees of this Bond or any portion or portions hereof (in each case, the "registered owner") the aggregate principal amount of

_____*

in annual installments of principal due and payable on March 1 in each of the years, and in the respective principal amounts, as set forth in the following schedule:

Year*	Principal Amount*	Year*	Principal Amount*

* From Approval Certificate.

and to pay interest, calculated on the basis of a 360-day year composed of twelve 30-day months, from the date of initial delivery of this Bond to the Underwriters (as defined in the Bond Resolution (hereinafter defined)), on the balance of each such installment of principal, respectively, from time to time remaining unpaid, at the rates as follows:

Year*	Rate*	Year*	Rate*

with said interest being payable semiannually on each March 1 and September 1, commencing _____*, while this Bond or any portion hereof is outstanding and unpaid.

THE INSTALLMENTS OF PRINCIPAL OF AND THE INTEREST ON this Bond are payable in lawful money of the United States of America, without exchange or collection charges. The installments of principal and the interest on this Bond are payable to the registered owner hereof through the services of THE BANK OF NEW YORK MELLON TRUST COMPANY, NATIONAL ASSOCIATION, DALLAS, TEXAS, which is the "Paying Agent/Registrar" for this Bond. Payment of all principal of and interest on this Bond shall be made by the Paying Agent/Registrar to the registered owner hereof on each principal and/or interest payment date by check, dated as of such date, drawn by the Paying Agent/Registrar on, and payable solely from, funds of the Issuer required by the resolution authorizing the issuance of this Bond (the "Bond Resolution") to be on deposit with the Paying Agent/Registrar for such purpose as hereinafter provided; and such check shall be sent by the Paying Agent/Registrar by United States mail, first-class postage prepaid, on each such principal and/or interest payment date, to the registered owner hereof, at the address of the registered owner, as it appeared at the close of business on the 15th day of the month next preceding each such date (the "Record Date") on the Registration Books kept by the Paying Agent/ Registrar, as hereinafter described. The Issuer covenants with the registered owner of this Bond that on or before each principal and/or interest payment date for this Bond it will make available to the Paying Agent/Registrar, from the "Interest and Redemption Fund" created by the Bond Resolution, the amounts required to provide for the payment, in immediately available funds, of all principal of and interest on this Bond, when due.

IF THE DATE for the payment of the principal of or interest on this Bond shall be a Saturday, Sunday, a legal holiday, or a day on which banking institutions in the City where the Paying Agent/Registrar is located are authorized by law or executive order to close, then the date for such payment shall be the next succeeding day which is not such a Saturday, Sunday, legal holiday, or day on which banking institutions are authorized to close; and payment on such date shall have the same force and effect as if made on the original date payment was due.

THIS BOND has been authorized in accordance with the Constitution and laws of the State of Texas in the principal amount of $_____*, for the purpose of obtaining funds (i) to pay for the planning, design, construction, and right of way costs related to the District's Water System,

* From Approval Certificate.

including additional water transmission and pumping facilities; development of new water resources, including costs related to the acquisition of out of state water and associated legal, engineering, and consulting costs; Cedar Creek Dam stabilization, pump station improvements, rebuilding Benbrook dechlorination facility, access bridges, monitoring equipment, generators, switches, instrumentation and other electrical equipment and improvements, and other construction, improvements, and repairs to the District's Water System; (ii) to fund a debt service reserve fund; and (iii) to pay costs of issuance of the Series 2014 Bonds.

ON _____ 1, ____, or any date thereafter, the unpaid installments of principal of this Bond may be prepaid or redeemed prior to their scheduled due dates, at the option of the Issuer, with funds derived from any available source, as a whole, or in part, and, if in part, the Issuer shall select and designate the installment or installments of principal, and the amount that is to be redeemed, and if less than a whole principal installment is to be called, the Issuer shall direct the Paying Agent/Registrar to call by lot or other customary method of random selection the portion of the principal installment to be redeemed (only in an integral multiple of $5,000), at the redemption price of the principal amount to be prepaid or redeemed, plus accrued interest to the date fixed for prepayment or redemption.

*[THE PRINCIPAL INSTALLMENTS OF THIS BOND maturing on March 1, ____ and March 1, ____ are subject to mandatory prepayment or redemption prior to maturity in part, at a price equal to the principal amount of this Bond or portions hereof to be prepaid or redeemed plus accrued interest to the date of prepayment or redemption, on March 1 in the each of years and in the amounts as follows:

Principal Installment due on March 1, ____

Years	Amounts

Principal Installment due on March 1, ____

Years	Amounts

the amount of any principal installment of this Bond required to be prepaid or redeemed pursuant to the operation of such mandatory prepayment or redemption provisions shall be reduced, at the option of the Issuer, by the principal amount of such principal installment of this Bond which, at

* From Approval Certificate, if applicable.

least 50 days prior to the mandatory prepayment or redemption date (1) shall have been acquired by the Issuer at a price not exceeding such principal amount plus accrued interest to the date of purchase thereof, (2) shall have been purchased by the Paying Agent/Registrar at the request of the Issuer at a price not exceeding such principal amount plus accrued interest to the date of purchase, or (3) shall have been prepaid or redeemed pursuant to the optional prepayment or redemption provisions and not theretofore credited against a mandatory prepayment or redemption requirement.]

AT LEAST 30 days prior to the date fixed for any such prepayment or redemption a written notice of such prepayment or redemption shall be mailed by the Paying Agent/Registrar to the registered owner hereof. By the date fixed for any such prepayment or redemption due provision shall be made by the Issuer with the Paying Agent/Registrar for the payment of the required prepayment or redemption price for this Bond or the portion hereof which is to be so prepaid or redeemed, plus accrued interest thereon to the date fixed for prepayment or redemption. If such written notice of prepayment or redemption is given, and if due provision for such payment is made, all as provided above, this Bond, or the portion thereof which is to be so prepaid or redeemed, thereby automatically shall be treated as prepaid or redeemed prior to its scheduled due date, and shall not bear interest after the date fixed for its prepayment or redemption, and shall not be regarded as being outstanding except for the right of the registered owner to receive the prepayment or redemption price plus accrued interest to the date fixed for prepayment or redemption from the Paying Agent/Registrar out of the funds provided for such payment. The Paying Agent/Registrar shall record in the Registration Books all such prepayments or redemptions of principal of this Bond or any portion hereof.

THIS BOND, to the extent of the unpaid principal balance hereof, or any unpaid portion hereof in any integral multiple of $5,000, may be assigned by the initial registered owner hereof and shall be transferred only in the Registration Books of the Issuer kept by the Paying Agent/Registrar acting in the capacity of registrar for the Bonds, upon the terms and conditions set forth in the Bond Resolution. Among other requirements for such transfer, this Bond must be presented and surrendered to the Paying Agent/ Registrar for cancellation, together with proper instruments of assignment, in form and with guarantee of signatures satisfactory to the Paying Agent/Registrar, evidencing assignment by the initial registered owner of this Bond, or any portion or portions hereof in any integral multiple of $5,000, to the assignee or assignees in whose name or names this Bond or any such portion or portions hereof is or are to be transferred and registered. Any instrument or instruments of assignment satisfactory to the Paying Agent/Registrar may be used to evidence the assignment of this Bond or any such portion or portions hereof by the initial registered owner hereof. A new bond or bonds payable to such assignee or assignees (which then will be the new registered owner or owners of such new Bond or Bonds) or to the initial registered owner as to any portion of this Bond which is not being assigned and transferred by the initial registered owner, shall be delivered by the Paying Agent/Registrar in conversion of and exchange for this Bond or any portion or portions hereof, but solely in the form and manner as provided in the next paragraph hereof for the conversion and exchange of this Bond or any portion hereof. The registered owner of this Bond shall be deemed and treated by the Issuer and the Paying Agent/Registrar as the absolute owner hereof for all purposes, including payment and discharge of liability upon this Bond to the extent of such payment, and the Issuer and the Paying Agent/Registrar shall not be affected by any notice to the contrary.

AS PROVIDED above and in the Bond Resolution, this Bond, to the extent of the unpaid principal balance hereof, may be converted into and exchanged for a like aggregate principal amount of fully registered bonds, without interest coupons, payable to the assignee or assignees duly designated in writing by the initial registered owner hereof, or to the initial registered owner as to any portion of this Bond which is not being assigned and transferred by the initial registered owner, in any denomination or denominations in any integral multiple of $5,000 (subject to the requirement hereinafter stated that each substitute bond issued in exchange for any portion of this Bond shall have a single stated principal maturity date), upon surrender of this Bond to the Paying Agent/Registrar for cancellation, all in accordance with the form and procedures set forth in the Bond Resolution. If this Bond or any portion hereof is assigned and transferred or converted each bond issued in exchange for any portion hereof shall have a single stated principal maturity date corresponding to the due date of the installment of principal of this Bond or portion hereof for which the substitute bond is being exchanged, and shall bear interest at the rate applicable to and borne by such installment of principal or portion thereof. Such bonds, respectively, shall be subject to redemption prior to maturity on the same dates and for the same prices as the corresponding installment of principal of this Bond or portion hereof for which they are being exchanged. No such bond shall be payable in installments, but shall have only one stated principal maturity date. AS PROVIDED IN THE BOND RESOLUTION, THIS BOND IN ITS PRESENT FORM MAY BE ASSIGNED AND TRANSFERRED OR CONVERTED ONCE ONLY, and to one or more assignees, but the bonds issued and delivered in exchange for this Bond or any portion hereof may be assigned and transferred, and converted, subsequently, as provided in the Bond Resolution. The Issuer shall pay the Paying Agent/Registrar's standard or customary fees and charges for transferring, converting, and exchanging this Bond or any portion thereof, but the one requesting such transfer, conversion, and exchange shall pay any taxes or governmental charges required to be paid with respect thereto. The Paying Agent/Registrar shall not be required to make any such assignment, conversion, or exchange (i) during the period commencing with the close of business on any Record Date and ending with the opening of business on the next following principal or interest payment date, or, (ii) with respect to any Bond or portion thereof called for prepayment or redemption prior to maturity, within 45 days prior to its prepayment or redemption date.

IN THE EVENT any Paying Agent/Registrar for this Bond is changed by the Issuer, resigns, or otherwise ceases to act as such, the Issuer has covenanted in the Bond Resolution that it promptly will appoint a competent and legally qualified substitute therefor, and promptly will cause written notice thereof to be mailed to the registered owner of this Bond.

IT IS HEREBY certified, recited, and covenanted that this Bond has been duly and validly authorized, issued, and delivered; that all acts, conditions, and things required or proper to be performed, exist, and be done precedent to or in the authorization, issuance, and delivery of this Bond have been performed, existed, and been done in accordance with law; that this Bond and the interest thereon, are special obligations of the Issuer which, together with other outstanding bonds of the Issuer, are secured by and payable equally and ratably on a parity from a first lien on and pledge of the "Pledged Revenues," as defined in the Bond Resolution, which include the "Net Revenues of the District's Water System," as defined in the Bond Resolution, which specifically include certain amounts to be received by the Issuer (i) pursuant to the "Tarrant County Regional Water Supply Facilities Contract," dated August 29, 1979, among the Issuer and the Cities of Fort Worth and Mansfield, Texas, the "Tarrant County Regional Water Supply Facilities Supplemental

Contract For Trinity River Authority of Texas," dated as of March 12, 1979 between the Issuer and Trinity River Authority of Texas, and the "Tarrant County Regional Water Supply Facilities Amendatory Contract", dated September 1, 1982, among the Issuer, the Cities of Fort Worth, Arlington, and Mansfield, Texas, and Trinity River Authority of Texas, which last named amendatory contract consolidates the previous contracts between such parties with respect to the Issuer's Water System into one instrument and sets forth the entire agreement between such parties with respect to the Issuer's Water System, and (ii) pursuant to contracts with other water customers of the Issuer.

THE ISSUER has reserved the right, subject to the restrictions stated in the Bond Resolution, to issue Additional Bonds payable from and secured by a first lien on and pledge of the "Pledged Revenues" on a parity with this Bond.

THE ISSUER also has reserved the right to amend the Bond Resolution, with the approval of the owners of 51% of the outstanding bonds secured by a first lien on the Pledged Revenues, subject to the restrictions as stated in the Bond Resolution.

THE REGISTERED OWNER hereof shall never have the right to demand payment of this Bond or the interest hereon out of any funds raised or to be raised by taxation or from any source whatsoever other than specified in the Bond Resolution.

BY BECOMING the registered owner of this Bond, the registered owner thereby acknowledges all of the terms and provisions of the Bond Resolution, agrees to be bound by such terms and provisions, acknowledges that the Bond Resolution is duly recorded and available for inspection in the official minutes and records of the governing body of the Issuer, and agrees that the terms and provisions of this Bond and the Bond Resolution constitute a contract between the registered owner hereof and the Issuer.

IN WITNESS WHEREOF, the Issuer has caused this Bond to be signed with the manual or facsimile signature of the President of the Board of Directors of the Issuer and countersigned with the manual or facsimile signature of the Secretary of the Board of Directors of the Issuer, has caused the official seal of the Issuer to be duly impressed, or placed in facsimile, on this Bond and has caused this Bond to be dated as of _____*, 2014.

xxxxxxx	xxxxxxx
Secretary, Board of Directors	President, Board of Directors

(DISTRICT SEAL)

*From Approval Certificate.

FORM OF REGISTRATION CERTIFICATE OF THE
COMPTROLLER OF PUBLIC ACCOUNTS:

COMPTROLLER'S REGISTRATION CERTIFICATE: REGISTER NO.

I hereby certify that this Bond has been examined, certified as to validity, and approved by the Attorney General of the State of Texas, and that this Bond has been registered by the Comptroller of Public Accounts of the State of Texas.

Witness my signature and seal this

_____
Comptroller of Public Accounts of the State of Texas

(COMPTROLLER'S SEAL)

Section 6. CHARACTERISTICS OF THE Series 2014 BONDS. (a) Registration, Transfer, Conversion and Exchange; Authentication. (a) The Issuer shall keep or cause to be kept at the principal corporate trust office of The Bank of New York Mellon Trust Company, National Association, Dallas, Texas (the "Paying Agent/Registrar") books or records for the registration of the transfer, conversion and exchange of the Series 2014 Bonds (the "Registration Books"), and the Issuer hereby appoints the Paying Agent/Registrar as its registrar and transfer agent to keep such books or records and make such registrations of transfers, conversions and exchanges under such reasonable regulations as the Issuer and Paying Agent/Registrar may prescribe; and the Paying Agent/Registrar shall make such registrations, transfers, conversions and exchanges as herein provided. The Paying Agent/Registrar shall obtain and record in the Registration Books the address of the registered owner of each Series 2014 Bond to which payments with respect to the Series 2014 Bonds shall be mailed, as herein provided; but it shall be the duty of each registered owner to notify the Paying Agent/Registrar in writing of the address to which payments shall be mailed, and such interest payments shall not be mailed unless such notice has been given. To the extent possible and under reasonable circumstances, all transfers of Series 2014 Bonds shall be made within three business days after request and presentation thereof. The Issuer shall have the right to inspect the Registration Books during regular business hours of the Paying Agent/Registrar, but otherwise the Paying Agent/Registrar shall keep the Registration Books confidential and, unless otherwise required by law, shall not permit their inspection by any other entity. The Paying Agent/Registrar's standard or customary fees and charges for making such registration, transfer, conversion, exchange and delivery of a substitute Series 2014 Bond or Series 2014 Bonds shall be paid as provided in the FORM OF Series 2014 BOND set forth in this Resolution. Registration of assignments, transfers, conversions and exchanges of Series 2014 Bonds shall be made in the manner provided and with the effect stated in the FORM OF Series 2014 BOND set forth in this Resolution. Each substitute Series 2014 Bond shall bear a letter and/or number to distinguish it from each other Series 2014 Bond.

An authorized representative of the Paying Agent/Registrar shall, before the delivery of any such Series 2014 Bond, date and manually sign the Paying Agent/Registrar's Authentication Certificate, and no such Series 2014 Bond shall be deemed to be issued or outstanding unless such Certificate is so executed. The Paying Agent/Registrar promptly shall cancel all paid Series 2014

Bonds surrendered for conversion and exchange. No additional ordinances, orders, or resolutions need be passed or adopted by the governing body of the Issuer or any other body or person so as to accomplish the foregoing conversion and exchange of any Series 2014 Bond or portion thereof, and the Paying Agent/Registrar shall provide for the printing, execution, and delivery of the substitute Series 2014 Bonds in the manner prescribed herein, and said Series 2014 Bonds shall be of type composition printed on paper of customary weight and strength. Pursuant to Subchapter D, Chapter 1201, Texas Government Code, the duty of conversion and exchange of Series 2014 Bonds as aforesaid is hereby imposed upon the Paying Agent/Registrar, and, upon the execution of said Certificate, the converted and exchanged Series 2014 Bond shall be valid, incontestable, and enforceable in the same manner and with the same effect as the Series 2014 Bonds which initially were issued and delivered pursuant to this Resolution, approved by the Attorney General, and registered by the Comptroller of Public Accounts.

(b) Payment of Series 2014 Bonds and Interest. The Issuer hereby further appoints the Paying Agent/Registrar to act as the paying agent for paying the principal of and interest on the Series 2014 Bonds, all as provided in this Resolution. The Paying Agent/Registrar shall keep proper records of all payments made by the Issuer and the Paying Agent/Registrar with respect to the Series 2014 Bonds.

(c) In General. The Series 2014 Bonds (i) shall be issued in fully registered form, without interest coupons, with the principal of and interest on such Series 2014 Bonds to be payable only to the registered owners thereof, (ii) if so provided in the Approval Certificate, may and/or shall be redeemed prior to their scheduled maturities, (iii) may be transferred and assigned, (iv) may be converted and exchanged for other Series 2014 Bonds, (v) shall have the characteristics, (vi) shall be signed, sealed, executed and authenticated, (vii) shall be payable as to principal and interest, and (viii) shall be administered and the Paying Agent/Registrar and the Issuer shall have certain duties and responsibilities with respect to the Series 2014 Bonds, all as provided, and in the manner and to the effect as required or indicated, in the FORM OF Series 2014 BOND set forth in this Resolution. The Series 2014 Bonds initially issued and delivered pursuant to this Resolution are not required to be, and shall not be, authenticated by the Paying Agent/Registrar, but on each substitute Series 2014 Bond issued in conversion of and exchange for any Series 2014 Bond or Series 2014 Bonds issued under this Resolution the Paying Agent/Registrar shall execute the PAYING AGENT/REGISTRAR'S AUTHENTICATION CERTIFICATE, in the form set forth in the FORM OF Series 2014 BOND.

(d) Substitute Paying Agent/Registrar. The Issuer covenants with the registered owners of the Series 2014 Bonds that at all times while the Series 2014 Bonds are outstanding the Issuer will provide a competent and legally qualified bank, trust company, financial institution, or other agency to act as and perform the services of Paying Agent/Registrar for the Series 2014 Bonds under this Resolution, and that the Paying Agent/Registrar will be one entity. The Issuer reserves the right to, and may, at its option, change the Paying Agent/Registrar upon not less than 120 days written notice to the Paying Agent/Registrar, to be effective not later than 60 days prior to the next principal or interest payment date after such notice. In the event that the entity at any time acting as Paying Agent/Registrar (or its successor by merger, acquisition, or other method) should resign or otherwise cease to act as such, the Issuer covenants that promptly it will appoint a competent and legally qualified bank, trust company, financial institution, or other agency to act as Paying Agent/Registrar

under this Resolution. Upon any change in the Paying Agent/Registrar, the previous Paying Agent/Registrar promptly shall transfer and deliver the Registration Books (or a copy thereof), along with all other pertinent books and records relating to the Series 2014 Bonds, to the new Paying Agent/Registrar designated and appointed by the Issuer. Upon any change in the Paying Agent/Registrar, the Issuer promptly will cause a written notice thereof to be sent by the new Paying Agent/Registrar to each registered owner of the Series 2014 Bonds, by United States mail, first-class postage prepaid, which notice also shall give the address of the new Paying Agent/Registrar. By accepting the position and performing as such, each Paying Agent/Registrar shall be deemed to have agreed to the provisions of this Resolution, and a certified copy of this Resolution shall be delivered to each Paying Agent/Registrar.

(e) Reporting Requirements of Paying Agent/Registrar. To the extent required by the Code and the regulations promulgated and pertaining thereto, it shall be the duty of the Paying Agent/Registrar, on behalf of the Issuer, to report to the owners of the Series 2014 Bonds and the Internal Revenue Service (i) the amount of "reportable payments," if any, subject to backup withholding during each year and the amount of tax withheld, if any, with respect to payments of the Series 2014 Bonds and (ii) the amount of interest or amount treated as interest on the Series 2014 Bonds and required to be included in gross income of the owner thereof.

(f) Book-Entry Only System. The Series 2014 Bonds issued in exchange for the Initial Bond shall be initially issued in the form of a separate single fully registered Series 2014 Bond for each of the maturities thereof. Upon initial issuance, the ownership of each such Series 2014 Bond shall be registered in the name of Cede & Co., as nominee of Depository Trust Company of New York ("DTC"), and except as provided in subsection (f) hereof, all of the outstanding Series 2014 Bonds shall be registered in the name of Cede & Co., as nominee of DTC.

With respect to Series 2014 Bonds registered in the name of Cede & Co., as nominee of DTC, the Issuer and the Paying Agent/Registrar shall have no responsibility or obligation to any DTC Participant or to any person on behalf of whom such a DTC Participant holds an interest on the Series 2014 Bonds. Without limiting the immediately preceding sentence, the Issuer and the Paying Agent/Registrar shall have no responsibility or obligation with respect to (i) the accuracy of the records of DTC, Cede & Co. or any DTC Participant with respect to any ownership interest in the Series 2014 Bonds, (ii) the delivery to any DTC Participant or any other person, other than a Bondholder, as shown on the Registration Books, of any notice with respect to the Series 2014 Bonds, including any notice of redemption, or (iii) the payment to any DTC Participant or any other person, other than a Bondholder, as shown in the Registration Books of any amount with respect to principal of, premium, if any, or interest on, as the case may be, the Series 2014 Bonds. Notwithstanding any other provision of this Resolution to the contrary, the Issuer and the Paying Agent/Registrar shall be entitled to treat and consider the person in whose name each Series 2014 Bond is registered in the Registration Books as the absolute owner of such Series 2014 Bond for the purpose of payment of principal, premium, if any, and interest, as the case may be, with respect to such Series 2014 Bond, for the purpose of giving notices of redemption and other matters with respect to such Series 2014 Bond, for the purpose of registering transfers with respect to such Series 2014 Bond, and for all other purposes whatsoever. The Paying Agent/Registrar shall pay all principal of and interest on the Series 2014 Bonds only to or upon the order of the respective owners, as shown in the Registration Books as provided in this Resolution, or their respective attorneys duly

authorized in writing, and all such payments shall be valid and effective to fully satisfy and discharge the Issuer's obligations with respect to payment of principal of, premium, if any, and interest on, or as the case may be, the Series 2014 Bonds to the extent of the sum or sums so paid. No person other than an owner, as shown in the Registration Books, shall receive a Series 2014 Bond certificate evidencing the obligation of the Issuer to make payments of principal, premium, if any, and interest, as the case may be, pursuant to this Resolution. Upon delivery by DTC to the Paying Agent/Registrar of written notice to the effect that DTC has determined to substitute a new nominee in place of Cede & Co., and subject to the provisions in this Resolution with respect to interest checks being mailed to the registered owner at the close of business on the Record Date, the word "Cede & Co." in this Resolution shall refer to such new nominee of DTC.

(g) Successor Securities Depository; Transfers Outside Book-Entry Only System. In the event that the Issuer or the Paying Agent/Registrar determines that DTC is incapable of discharging its responsibilities described herein and in the representation letter of the Issuer to DTC and that it is in the best interest of the beneficial owners of the Series 2014 Bonds that they be able to obtain certificated Series 2014 Bonds, the Issuer or the Paying Agent/Registrar shall (i) appoint a successor securities depository, qualified to act as such under Section 17(a) of the Securities and Exchange Act of 1934, as amended, notify DTC and DTC Participants of the appointment of such successor securities depository and transfer one or more separate Series 2014 Bonds to such successor securities depository or (ii) notify DTC and DTC Participants of the availability through DTC of Series 2014 Bonds and transfer one or more separate Series 2014 Bonds to DTC Participants having Series 2014 Bonds credited to their DTC accounts. In such event, the Series 2014 Bonds shall no longer be restricted to being registered in the Registration Books in the name of Cede & Co., as nominee of DTC, but may be registered in the name of the successor securities depository, or its nominee, or in whatever name or names Bondholders transferring or exchanging Series 2014 Bonds shall designate, in accordance with the provisions of this Resolution.

(h) Payments to Cede & Co. Notwithstanding any other provision of this Resolution to the contrary, so long as any Series 2014 Bond is registered in the name of Cede & Co., as nominee of DTC, all payments with respect to principal of, premium, if any, and interest on, or as the case may be, such Series 2014 Bond and all notices with respect to such Series 2014 Bond shall be made and given, respectively, in the manner provided in the representation letter of the Issuer to DTC.

Section 7. FORM OF SERIES 2014 SUBSTITUTE BONDS. The form of all Series 2014 Bonds issued in conversion and exchange or replacement of any other Series 2014 Bond or portion thereof, including the form of Paying Agent/Registrar's Certificate to be printed on each of such Series 2014 Bonds, and the Form of Assignment to be printed on each of the Series 2014 Bonds, shall be, respectively, substantially as follows, with blank or bracketed information to be completed or deleted based upon the Approval Certificate, and with such appropriate variations, omissions, or insertions as are permitted or required by this Resolution.

FORM OF SERIES 2014 SUBSTITUTE BOND

THE FOLLOWING TWO BRACKETED PARAGRAPHS ARE TO BE DELETED IF BOND IS NOT BOOK ENTRY ONLY:

[Unless this Bond is presented by an authorized representative of The Depository Trust Company, a New York corporation ("DTC") to the Issuer or its agent for registration of transfer, exchange, or payment, and any Bond issued is registered in the name of Cede & Co. or in such other name as is requested by an authorized representative of DTC (and any payment is made to Cede & Co. or to such other entity as is requested by an authorized representative of DTC), ANY TRANSFER, PLEDGE, OR OTHER USE HEREOF FOR VALUE OR OTHERWISE BY OR TO ANY PERSON IS WRONGFUL inasmuch as the registered owner hereof, Cede & Co., has an interest herein.

As provided in the Indenture referred to herein, until the termination of the system of book-entry-only transfers through DTC, and notwithstanding any other provision of the Indenture to the contrary, this Bond may be transferred, in whole but not in part, only to a nominee of DTC, or by a nominee of DTC to DTC or a nominee of DTC, or by DTC or a nominee of DTC to any successor securities depository or any nominee thereof.]

NO.____ PRINCIPAL AMOUNT
$_____

UNITED STATES OF AMERICA
STATE OF TEXAS
TARRANT REGIONAL WATER DISTRICT,
A WATER CONTROL AND IMPROVEMENT DISTRICT,
WATER REVENUE BOND,
SERIES 2014

INTEREST RATE	MATURITY DATE	ISSUE DATE	CUSIP NO.
%		_____*, 2014	

ON THE MATURITY DATE specified above TARRANT REGIONAL WATER DISTRICT, A WATER CONTROL AND IMPROVEMENT DISTRICT (the "Issuer"), being a political subdivision of the State of Texas, hereby promises to pay to CEDE & CO. or to the registered assignee hereof (either being hereinafter called the "registered owner") the principal amount of _____ DOLLARS and to pay interest thereon, calculated on the basis of a 360-day year composed of twelve 30-day months, from the Issue Date specified above, to the Maturity Date specified above, *[or the date of redemption prior to maturity,] at the interest rate per annum specified above; with interest being payable semiannually on each March 1 and September 1, commencing _____**, except that if the date of authentication of this Bond is later than the first Record Date (hereinafter defined), such principal amount shall bear interest from the interest payment date next preceding the date of authentication, unless such date of authentication is after any Record Date (hereinafter defined) but on or before the next following interest payment date, in which case such principal amount shall bear interest from such next following interest payment date.

* Date of delivery to the Underwriters (as defined in section 31 hereof).
** From Approval Certificate.

THE PRINCIPAL OF AND INTEREST ON this Bond are payable in lawful money of the United States of America, without exchange or collection charges. The principal of this Bond shall be paid to the registered owner hereof upon presentation and surrender of this Bond at maturity or upon the date fixed for its redemption prior to maturity, at the principal corporate trust office of The Bank of New York Mellon Trust Company, National Association, Dallas, Texas, which is the "Paying Agent/Registrar" for this Bond. The payment of interest on this Bond shall be made by the Paying Agent/Registrar to the registered owner hereof on each interest payment date by check dated as of such interest payment date, drawn by the Paying Agent/Registrar on, and payable solely from, funds of the Issuer required by the resolution authorizing the issuance of the Bonds (the "Bond Resolution") to be on deposit with the Paying Agent/Registrar for such purpose as hereinafter provided; and such check shall be sent by the Paying Agent/Registrar by United States mail, first-class postage prepaid, on each such interest payment date, to the registered owner hereof, at the address of the registered owner, as it appeared at the close of business on the 15th day of the month next preceding each such date (the "Record Date") on the Registration Books kept by the Paying Agent/Registrar, as hereinafter described. However, notwithstanding the foregoing provisions, (1) the payment of such interest may be made by any other method acceptable to the Paying Agent/Registrar and requested by, and at the risk and expense of, the registered owner hereof and (2) upon the written request, and at the risk and expense of, the registered owner of any Bond of this Series in the amount of $1,000,000 or more, delivered to the Paying Agent/Registrar not less than 15 days prior to any interest payment date, payment of the interest due on such Bond on such date shall be paid on such date by wire transfer to any designated account in the United States of America which has available to it the wire service facilities of the Federal Reserve Bank. Any accrued interest due upon the redemption of this Bond prior to maturity as provided herein shall be paid to the registered owner at the principal corporate trust office of the Paying Agent/Registrar upon presentation and surrender of this Bond for redemption and payment at the principal corporate trust office of the Paying Agent/Registrar. The Issuer covenants with the registered owner of this Bond that on or before each principal payment date, interest payment date, and accrued interest payment date for this Bond it will make available to the Paying Agent/Registrar, from the "Interest and Redemption Fund" created by the Bond Resolution, the amounts required to provide for the payment, in immediately available funds, of all principal of and interest on the Bonds, when due.

IF THE DATE for the payment of the principal of or interest on this Bond shall be a Saturday, Sunday, a legal holiday, or a day on which banking institutions in the City where the Paying Agent/Registrar is located are authorized by law or executive order to close, then the date for such payment shall be the next succeeding day which is not such a Saturday, Sunday, legal holiday, or day on which banking institutions are authorized to close; and payment on such date shall have the same force and effect as if made on the original date payment was due.

THIS BOND is one of an issue of Bonds dated as of _____*, 2014, authorized in accordance with the Constitution and laws of the State of Texas in the principal amount of $_____* for the purpose of obtaining funds (i) to pay for the planning, design, construction, and right of way costs related to the District's Water System, including additional water transmission and pumping facilities; development of new water resources, including costs related to the acquisition of out of state water and associated legal, engineering, and consulting costs; Cedar Creek Dam stabilization, pump station improvements, rebuilding Benbrook dechlorination facility, access bridges, monitoring equipment, generators, switches, instrumentation and other electrical equipment

and improvements, and other construction, improvements, and repairs to the District's Water System; (ii) to fund a debt service reserve fund; and (iii) to pay costs of issuance of the Series 2014 Bonds.

ON _____ 1, ____, or any date thereafter, the outstanding Bonds may be redeemed prior to their scheduled maturities, at the option of the Issuer, with funds derived from any available source, as a whole, or in part, and, if in part, the Issuer shall select and designate the maturity, or maturities, and the amount that is to be redeemed, and if less than a whole maturity is to be redeemed, the Issuer shall direct the Paying Agent/Registrar to call by lot or other customary method of random selection the Bonds or portions thereof to be redeemed (provided that the Bonds to be redeemed only in integral multiples of $5,000), at the redemption price of the principal amount of the Bonds to be redeemed, plus accrued interest to the date fixed for redemption.

*[THE BONDS maturing on March 1, ____ and March 1, ____ (the "Term Bonds") are subject to mandatory redemption prior to maturity in part, by lot or other customary random method selected by the Paying Agent/Registrar, at a redemption price equal to the principal amount of the Term Bonds or portions thereof to be redeemed plus accrued interest to the redemption date, on June 1 in each of the years and in the principal amounts as follows:

Term Bonds maturing on March 1, ____

Years	Amounts

Term Bonds maturing on March 1, ____

Years	Amounts

The principal amount of the Term Bonds of a maturity required to be redeemed pursuant to the operation of such mandatory redemption provisions shall be reduced, at the option of the Issuer, by the principal amount of the Term Bonds of such maturity which, at least 50 days prior to the mandatory redemption date (1) shall have been acquired by the Issuer at a price not exceeding the principal amount of such Term Bonds plus accrued interest to the date of purchase thereof, and delivered to the Paying Agent/Registrar for cancellation, (2) shall have been purchased and canceled by the Paying Agent/Registrar at the request of the Issuer at a price not exceeding the principal

* From Approval Certificate, if applicable.

amount of such Term Bonds plus accrued interest to the date of purchase, or (3) shall have been redeemed pursuant to the optional redemption provisions and not theretofore credited against a mandatory redemption requirement.]

DURING ANY PERIOD in which ownership of the Bonds is determined by a book entry at a securities depository for the Bonds, if fewer than all of the Bonds of the same maturity and bearing the same interest rate are to be redeemed, the particular Bonds of such maturity and bearing such interest rate shall be selected in accordance with the arrangements between the Issuer and the securities depository.

AT LEAST 30 days prior to the date fixed for any redemption of Bonds or portions thereof prior to maturity at the option of the Issuer, a written notice of such redemption shall be sent by the Paying Agent/Registrar by United States mail, first-class postage prepaid, to the registered owner appearing on the Registration Books at the close of business on the day next preceding the date of mailing of such notice; provided, however, that any notice so mailed shall be conclusively presumed to have been duly given and the failure to receive such notice, or any defect therein shall not affect the validity or effectiveness of the proceedings for the redemption of any Bond at the option of the Issuer. By the date fixed for any such redemption due provision shall be made with the Paying Agent/Registrar for the payment of the required redemption price for the Bonds or portions thereof which are to be so redeemed, plus accrued interest thereon to the date fixed for redemption. If such written notice of redemption is mailed and if due provision for such payment is made, all as provided above, the Bonds or portions thereof which are to be so redeemed thereby automatically shall be treated as redeemed prior to their scheduled maturities, and they shall not bear interest after the date fixed for redemption, and they shall not be regarded as being outstanding except for the right of the registered owner to receive the redemption price plus accrued interest from the Paying Agent/Registrar out of the funds provided for such payment. If a portion of any Bond shall be redeemed a substitute Bond or Bonds having the same maturity date, bearing interest at the same rate, in any denomination or denominations in any integral multiple of $5,000, at the written request of the registered owner, and in aggregate principal amount equal to the unredeemed portion thereof, will be issued to the registered owner upon the surrender thereof for cancellation, at the expense of the Issuer, all as provided in the Bond Resolution.

THIS BOND OR ANY PORTION OR PORTIONS HEREOF IN ANY INTEGRAL MULTIPLE OF $5,000 may be assigned and shall be transferred only in the Registration Books of the Issuer kept by the Paying Agent/Registrar acting in the capacity of registrar for the Bonds, upon the terms and conditions set forth in the Bond Resolution. Among other requirements for such assignment and transfer, this Bond must be presented and surrendered to the Paying Agent/Registrar, together with proper instruments of assignment, in form and with guarantee of signatures satisfactory to the Paying Agent/Registrar, evidencing assignment of this Bond or any portion or portions hereof in any integral multiple of $5,000 to the assignee or assignees in whose name or names this Bond or any such portion or portions hereof is or are to be transferred and registered. The form of Assignment printed or endorsed on this Bond shall be executed by the registered owner or its duly authorized attorney or representative, to evidence the assignment hereof. A new Bond or Bonds payable to such assignee or assignees (which then will be the new registered owner or owners of such new Bond or Bonds), or to the previous registered owner in the case of the assignment and transfer of only a portion of this Bond, may be delivered by the Paying Agent/Registrar in

conversion of and exchange for this Bond, all in the form and manner as provided in the next paragraph hereof for the conversion and exchange of other Bonds. The Issuer shall pay the Paying Agent/Registrar's standard or customary fees and charges for making such transfer, but the one requesting such transfer shall pay any taxes or other governmental charges required to be paid with respect thereto. The Paying Agent/Registrar shall not be required to make transfers of registration of this Bond or any portion hereof (i) during the period commencing with the close of business on any Record Date and ending with the opening of business on the next following principal or interest payment date, or, (ii) with respect to any Bond or any portion thereof called for redemption prior to maturity, within 45 days prior to its redemption date. The registered owner of this Bond shall be deemed and treated by the Issuer and the Paying Agent/Registrar as the absolute owner hereof for all purposes, including payment and discharge of liability upon this Bond to the extent of such payment, and the Issuer and the Paying Agent/Registrar shall not be affected by any notice to the contrary.

ALL BONDS OF THIS SERIES are issuable solely as fully registered bonds, without interest coupons, in the denomination of any integral multiple of $5,000. As provided in the Bond Resolution, this Bond, or any unredeemed portion hereof, may, at the request of the registered owner or the assignee or assignees hereof, be converted into and exchanged for a like aggregate principal amount of fully registered bonds, without interest coupons, payable to the appropriate registered owner, assignee, or assignees, as the case may be, having the same maturity date, and bearing interest at the same rate, in any denomination or denominations in any integral multiple of $5,000 as requested in writing by the appropriate registered owner, assignee, or assignees, as the case may be, upon surrender of this Bond to the Paying Agent/Registrar for cancellation, all in accordance with the form and procedures set forth in the Bond Resolution. The Issuer shall pay the Paying Agent/Registrar's standard or customary fees and charges for transferring, converting, and exchanging any Bond or any portion thereof, but the one requesting such transfer, conversion, and exchange shall pay any taxes or governmental charges required to be paid with respect thereto as a condition precedent to the exercise of such privilege of conversion and exchange. The Paying Agent/Registrar shall not be required to make any such conversion and exchange *[(i)] during the period commencing with the close of business on any Record Date and ending with the opening of business on the next following principal or interest payment date*[, or, (ii) with respect to any Bond or portion thereof called for redemption prior to maturity, within 45 days prior to its redemption date].

IN THE EVENT any Paying Agent/Registrar for the Bonds is changed by the Issuer, resigns, or otherwise ceases to act as such, the Issuer has covenanted in the Bond Resolution that it promptly will appoint a competent and legally qualified substitute therefor, and promptly will cause written notice thereof to be mailed to the registered owners of the Bonds.

IT IS HEREBY certified, recited, and covenanted that this Bond has been duly and validly authorized, issued, and delivered; that all acts, conditions, and things required or proper to be performed, exist, and be done precedent to or in the authorization, issuance, and delivery of this Bond have been performed, existed, and been done in accordance with law; that this Bond and the interest thereon, are special obligations of the Issuer which, together with other outstanding bonds of the Issuer, are secured by and payable equally and ratably on a parity from a first lien on and pledge of the "Pledged Revenues," as defined in the Bond Resolution, which include the "Net

Revenues of the District's Water System," as defined in the Bond Resolution, which specifically include certain amounts to be received by the Issuer (i) pursuant to the "Tarrant County Regional Water Supply Facilities Contract", dated August 29, 1979, among the Issuer and the Cities of Fort Worth and Mansfield, Texas, the "Tarrant County Regional Water Supply Facilities Supplemental Contract For Trinity River Authority of Texas," dated as of March 12, 1979 between the Issuer and Trinity River Authority of Texas, and the "Tarrant County Regional Water Supply Facilities Amendatory Contract," dated September 1, 1982, among the Issuer, the Cities of Fort Worth, Arlington, and Mansfield, Texas, and Trinity River Authority of Texas, which last named amendatory contract consolidates the previous contracts between such parties with respect to the Issuer's Water System into one instrument and sets forth the entire agreement between such parties with respect to the Issuer's Water System, and (ii) pursuant to contracts with other water customers of the Issuer.

THE ISSUER has reserved the right, subject to the restrictions stated in the Bond Resolution, to issue Additional Bonds payable from and secured by a first lien on and pledge of the "Pledged Revenues" on a parity with this Bond.

THE ISSUER also has reserved the right to amend the Bond Resolution, with the approval of the owners of 51% of the outstanding bonds secured by a first lien on the Pledged Revenues, subject to the restrictions stated in the Bond Resolution.

THE REGISTERED OWNER hereof shall never have the right to demand payment of this Bond or the interest hereon out of any funds raised or to be raised by taxation or from any source whatsoever other than as specified in the Bond Resolution.

BY BECOMING the registered owner of this Bond, the registered owner thereby acknowledges all of the terms and provisions of the Bond Resolution, agrees to be bound by such terms and provisions, acknowledges that the Bond Resolution is duly recorded and available for inspection in the official minutes and records of the governing body of the Issuer, and agrees that the terms and provisions of this Bond and the Bond Resolution constitute a contract between each registered owner hereof and the Issuer.

IN WITNESS WHEREOF, the Issuer has caused this Bond to be signed with the facsimile signature of the President of the Board of Directors of the Issuer and countersigned with the facsimile signature of the Secretary of the Board of Directors of the Issuer, and has caused the official seal of the Issuer to be duly impressed, or placed in facsimile, on this Bond.

XXXXXXX	XXXXXXX
Secretary, Board of Directors	President, Board of Directors

(DISTRICT SEAL)

FORM OF PAYING AGENT/REGISTRAR'S AUTHENTICATION CERTIFICATE

PAYING AGENT/REGISTRAR'S AUTHENTICATION CERTIFICATE

(To be executed if this Bond is not accompanied by an executed Registration Certificate of the Comptroller of Public Accounts of the State of Texas)

It is hereby certified that this Bond has been issued under the provisions of the Bond Resolution described in the text of this Bond; and that this Bond has been issued in conversion or replacement of, or in exchange for, a bond, bonds, or a portion of a bond or bonds of a Series which originally was approved by the Attorney General of the State of Texas and registered by the Comptroller of Public Accounts of the State of Texas.

Dated

THE BANK OF NEW YORK MELLON TRUST COMPANY, NATIONAL ASSOCIATION,
Dallas, Texas

By _____
Authorized Representative

FORM OF ASSIGNMENT

ASSIGNMENT

FOR VALUE RECEIVED, the undersigned sells, assigns and transfers unto

Please Insert Social Security or
Other Identifying Number of Assignee
/_____/

_____
(Name and Address of Assignee)
the within Bond and does hereby irrevocably constitute and appoint _____ to transfer said Bond on the books kept for registration thereof with full power of substitution in the premises.

Date: _____

_____

Signature Guaranteed: _____

NOTICE: The signature to this assignment must correspond with the name as it appears upon the face of the within Bond in every particular, without alteration or enlargement or any change whatever; and

NOTICE: Signature(s) must be guaranteed by an eligible guarantor institution participating in a Securities Transfer Association recognized signature guarantee program.

Section 8. ADDITIONAL DEFINITIONS. In addition to the definitions heretofore provided for, the following terms as used in this Resolution shall have the meanings set forth below, unless the text hereof specifically indicates otherwise:

The term "Additional Bonds" shall mean the additional parity revenue bonds permitted to be authorized in the future on a parity with the Bonds, as hereinafter provided in Sections 21 and 22 hereof.

The term "Board" shall mean the Board of Directors of the District, being the governing body of the District, and it is further resolved that the declarations and covenants of the District contained in this Resolution are made by, and for and on behalf of the Board and the District, and are binding upon the Board and the District for all purposes.

The terms "Bond Resolution" and "Resolution" shall mean this resolution authorizing the Series 2014 Bonds; and it is hereby resolved and provided that Sections 8 through 24 of this Bond Resolution are applicable to all of the Bonds, as hereinafter defined, and substantially restate and are supplemental to and cumulative of Sections 7 through 23 of the Series 2006 Bond Resolution, and Sections 8 through 24 of each of the Series 2008A Bond Resolution, Series 2008B Bond Resolution, Series 2009 Bond Resolution, Series 2010 Bond Resolution, Series 2010A Bond Resolution, Series 2010B Bond Resolution, Series 2012 Bond Resolution, and Series 2012A Bond Resolution, with the appropriate changes and additions which are required with respect to the issuance of the Series 2014 Bonds.

The term "Bonds" shall mean collectively (i) the unpaid and unrefunded Series 2006 Bonds, Series 2008A Bonds, Series 2008B Bonds, Series 2009 Bonds, Series 2010 Bonds, Series 2010A Bonds, Series 2010B Bonds, Series 2012 Bonds, and Series 2012A Bonds to be outstanding at any time after the delivery of the Initial Bond, and (ii) the Series 2014 Bonds.

The term "Contracts" shall mean collectively: (a) the "Tarrant County Regional Water Supply Facilities Contract", dated as of August 29, 1979, among the District and the Cities of Fort Worth and Mansfield, Texas, the "Tarrant County Regional Water Supply Facilities Supplemental Contract For Trinity River Authority of Texas", dated as of March 12, 1979, between the District and Trinity River Authority of Texas, and the "Tarrant County Regional Water Supply Facilities Amendatory Contract", dated September 1, 1982, among the District, the Cities of Fort Worth, Arlington, and Mansfield, Texas, and Trinity River Authority of Texas, which last named amendatory contract consolidates the previous contracts between such parties with respect to the System into one instrument and sets forth the entire agreement between such parties with respect to the System; and (b) all water supply contracts heretofore or hereafter executed between the District and other cities and customers in connection with the District's Water System.

The terms "District" and "Issuer" shall mean Tarrant Regional Water District, a Water Control and Improvement District.

The term "District's Water System," "Issuer's Water System," or "System" shall mean all of the District's existing water storage, treatment, transportation, distribution, and supply facilities, including all dams, reservoirs, and other properties, wherever located, (a) which are currently being used for water supply purposes and, to the extent financed with the proceeds from the sale of the

Bonds or Additional Bonds or moneys from the Contingency Fund (hereinafter created), all facilities acquired or constructed in the future, and all improvements to any of the foregoing, and (b) all other facilities which in the future are deliberately and specifically, at the option of the Board, made a part of the System by resolution of the Board, but such term does not include any oil, gas, and other mineral properties owned by the District or property disposed of from time to time in accordance with the provisions of Section 23(g) hereof, provided that any property acquired in substitution therefor shall be included in the System, along with all repairs to and other replacements of the System. In particular such term includes and shall include (i) all of the District's existing Cedar Creek Project, a dam and reservoir on Cedar Creek in Henderson and Kaufman Counties, Texas, and Eagle Mountain Dam and Reservoir and Bridgeport Dam and Reservoir, which are water supply facilities of the District on the West Fork of the Trinity River, Richland-Chambers Reservoir in Navarro and Freestone Counties, Texas, and all transportation, storage, and other facilities related to all of the foregoing and (ii) the Projects which were, or are to be, financed with the proceeds from the sale of bonds originally authorized by the Series 1983 Bond Resolution, the Series 1986 Bond Resolution, Series 1999 Bond Resolution, the Series 2002 Bond Resolution, the Series 2006 Bond Resolution, the Series 2008A Bond Resolution, the Series 2008B Bond Resolution, the Series 2009 Bond Resolution, the Series 2010 Bond Resolution, the Series 2010A Bond Resolution, the Series 2010B Bond Resolution, the Series 2012 Bond Resolution, the Series 2012A Bond Resolution, and the Series 2014 Bond Resolution and made a part of the System. Unless deliberately added to the System by the Board, at its option, in the manner prescribed above, said term does not include any District flood control facilities or facilities which provide waste treatment or other wastewater services of any kind. Said term does not include any facilities acquired or constructed by the District with the proceeds from the issuance of "Special Facilities Bonds," which are hereby defined as being revenue obligations of the District, which are not issued as Additional Bonds, and which are payable from any source, contract, or revenues whatsoever other than the Pledged Revenues; and Special Facilities Bonds may be issued for any lawful purpose and made payable from any source, contract, or revenues whatsoever other than the Pledged Revenues.

The term "Gross Revenues of the System" shall mean all of the revenues, income, rentals, rates, fees, and charges of every nature derived by the Board or the District from the operation and/or ownership of the System (except as hereinafter provided), including specifically all payments and amounts received by the Board or the District from Contracts, and any interest income from the investment of money in any Funds created or maintained pursuant to any resolution authorizing the issuance of Bonds or Additional Bonds, excepting only any Construction Fund created pursuant to any resolution authorizing any Bonds or Additional Bonds. There is excepted from such term, and such term does not include (i) revenues derived by the District from the production of oil, gas, and other minerals owned by the District, or the revenues derived from the granting, sale, or lease of the right to explore for and produce same, or (ii) the royalties, rentals, license fees, and other income (other than from water sales) derived by the District from (a) lands and assets owned by the District as flood control facilities or (b) property of the District at Eagle Mountain Dam and Reservoir and Bridgeport Dam and Reservoir on the West Fork of the Trinity River.

The term "Operating and Maintenance Expenses of the System" or "Current Expenses" shall mean all reasonable and necessary current costs of operation and maintenance of the System including, but not limited to, repairs and replacements, operating personnel, utilities, supervision, engineering, accounting, auditing, legal services, insurance premiums, paying agents fees, and any

other supplies and services, administration of the System, and equipment necessary for proper operation and maintenance of the System, as well as payments made for the use or operation of any property, and payments made by the District in satisfaction of judgments or other liabilities resulting from claims not covered by the District's insurance. Neither depreciation nor any other expense which does not represent a cash expenditure shall be considered an item of Operation and Maintenance Expense.

The terms "Net Revenues of the District's Water System", "Net Revenues of the System", and "Net Revenues" shall mean the Gross Revenues of the System less the Operation and Maintenance Expenses of the System.

The term "Pledged Revenues" shall mean: (a) the Net Revenues of the System and (b) any additional revenues, income, receipts, grants, donations, or other resources, received or to be received from any public or private source, whether pursuant to an agreement or otherwise, which in the future may, at the option of the District, be pledged to the payment of the Bonds or the Additional Bonds.

The term "Series 1983 Bond Resolution" shall mean the resolution adopted by the Board of Directors of the District on May 18, 1983, authorizing the Tarrant County Water Control and Improvement District Number One Water Revenue Bonds, Series 1983.

The term "Series 1986 Bond Resolution" shall mean the resolution adopted by the Board of Directors of the District on July 15, 1986, authorizing the Tarrant County Water Control and Improvement District Number One Water Revenue Bonds, Series 1986.

The term "Series 1999 Bond Resolution" shall mean the Resolution adopted by the Board of Directors of the District on May 18, 1999, authorizing Tarrant Regional Water District, a Water Control and Improvement District, Water Revenue Refunding and Improvement Bonds, Series 1999.

The term "Series 2006 Bond Resolution" shall mean the Resolution adopted by the Board of Directors of the District on March 21, 2006, authorizing Tarrant Regional Water District, a Water Control and Improvement District, Water Revenue Bonds, Series 2006.

The term "Series 2006 Bonds" shall mean all unpaid and unrefunded Series 2006 Bonds authorized by the Series 2006 Bond Resolution.

The term "Series 2008A Bond Resolution" shall mean the Resolution adopted by the Board of Directors of the District on June 17, 2008, authorizing Tarrant Regional Water District, a Water Control and Improvement District, Water Revenue Bonds, Series 2008A.

The term "Series 2008A Bonds" shall mean all unpaid and unrefunded Series 2008A Bonds authorized by the Series 2008A Bond Resolution.

The term "Series 2008B Bond Resolution" shall mean the Resolution adopted by the Board of Directors of the District on June 17, 2008, authorizing Tarrant Regional Water District, a Water Control and Improvement District, Water Revenue Bonds, Series 2008B.

The term "Series 2008B Bonds" shall mean all unpaid and unrefunded Series 2008B Bonds authorized by the Series 2008B Bond Resolution.

The term "Series 2009 Bond Resolution" shall mean the Resolution adopted by the Board of Directors of the District on January 20, 2009, authorizing Tarrant Regional Water District, a Water Control and Improvement District, Water Revenue Refunding and Improvement Bonds, Series 2009.

The term "Series 2009 Bonds" shall mean all unpaid and unrefunded Series 2009 Bonds authorized by the Series 2009 Bond Resolution.

The term "Series 2010 Bond Resolution" shall mean the Resolution adopted by the Board of Directors of the District on January 19, 2010, authorizing Tarrant Regional Water District, a Water Control and Improvement District, Water Revenue Bonds, Series 2010.

The term "Series 2010 Bonds" shall mean all unpaid and unrefunded Series 2010 Bonds authorized by the Series 2010 Bond Resolution.

The term "Series 2010A Bond Resolution" shall mean the Resolution adopted by the Board of Directors of the District on May 18, 2010, authorizing Tarrant Regional Water District, a Water Control and Improvement District, Water Revenue Bonds, Series 2010A.

The term "Series 2010A Bonds" shall mean all unpaid and unrefunded Series 2010A Bonds authorized by the Series 2010A Bond Resolution.

The term "Series 2010B Bond Resolution" shall mean the Resolution adopted by the Board of Directors of the District on May 18, 2010, authorizing Tarrant Regional Water District, a Water Control and Improvement District, Water Revenue Bonds, Series 2010B.

The term "Series 2010B Bonds" shall mean all unpaid and unrefunded Series 2010B Bonds authorized by the Series 2010B Bond Resolution.

The term "Series 2012 Bond Resolution" shall mean the Resolution adopted by the Board of Directors of the District on January 17, 2012, authorizing Tarrant Regional Water District, a Water Control and Improvement District, Water Revenue Refunding and Improvement Bonds, Series 2012.

The term "Series 2012 Bonds" shall mean all unpaid and unrefunded Series 2012 Bonds authorized by the Series 2012 Bond Resolution.

The term "Series 2012A Bond Resolution" shall mean the Resolution adopted by the Board of Directors of the District on September 18, 2012, authorizing Tarrant Regional Water District, a

Water Control and Improvement District, Water Revenue Refunding and Improvement Bonds, Series 2012A.

The term "Series 2012A Bonds" shall mean all unpaid and unrefunded Series 2012A Bonds authorized by the Series 2012A Bond Resolution

The term "Series 2014 Bonds" shall mean collectively the Initial Bond as described and defined in Sections 1, 2, and 3 of this Bond Resolution, and all substitute bonds exchanged therefor, as well as all other substitute bonds and replacement bonds issued pursuant to this Bond Resolution, all as provided for herein; and the Series 2014 Bonds are Additional Bonds issued to be payable from and secured by a first lien on and pledge of the Pledged Revenues equally and ratably on a parity with all of the other Bonds, as permitted by Sections 20 and 21 of the Series 2006 Bond Resolution, and Sections 21 and 22 of the Series 2008A Bond Resolution, the Series 2008B Bond Resolution, the Series 2009 Bond Resolution, the Series 2010 Bond Resolution, the Series 2010A Bond Resolution, the Series 2010B Bond Resolution, the Series 2012 Bond Resolution, and the Series 2012A Bond Resolution.

The terms "year" and "fiscal year" shall mean the District's fiscal year, which currently ends on September 30, but which subsequently may be any other 12 month period hereafter established by the District as a fiscal year for the purposes of the System and any resolution authorizing the Bonds or any Additional Bonds.

Section 9. PLEDGE. (a) That the Bonds, as defined above, and any Additional Bonds, and the interest thereon, are and shall be secured equally and ratably on a parity by and payable from a first lien on and pledge of the Pledged Revenues; and the Series 2014 Bonds are Additional Bonds payable from and secured by a first lien on and pledge of the Pledged Revenues, as permitted by Sections 20 and 21 of the Series 2006 Bond Resolution, and Sections 21 and 22 of the Series 2008A Bond Resolution, Series 2008B Bond Resolution, Series 2009 Bond Resolution, Series 2010 Bond Resolution, Series 2010A Bond Resolution, Series 2010B Bond Resolution, the Series 2012 Bond Resolution, and the Series 2012A Bond Resolution.

(b) That Chapter 1208, Government Code, applies to the issuance of the Bonds and the pledge of the revenues granted by the Issuer under this Section, and is therefore valid, effective, and perfected. Should Texas law be amended at any time while the Bonds are outstanding and unpaid, the result of such amendment being that the pledge of the revenues granted by the Issuer under this Section is to be subject to the filing requirements of Chapter 9, Business & Commerce Code, in order to preserve to the registered owners of the Bonds a security interest in said pledge, the Issuer agrees to take such measures as it determines are reasonable and necessary under Texas law to comply with the applicable provisions of Chapter 9, Business & Commerce Code and enable a filing of a security interest in said pledge to occur.

Section 10. REVENUE FUND. That there has been created and established, and there shall be maintained on the books of the District, and accounted for separate and apart from all other funds of the District, a special fund to be entitled the "Tarrant Regional Water District Water Revenue Bonds Revenue Fund" (hereinafter called the "Revenue Fund"). All Gross Revenues of the System (except investment interest and income from the other Funds hereinafter described and

maintained) shall be credited to the Revenue Fund immediately upon receipt. All Operation and Maintenance Expenses of the System shall be paid from such Gross Revenues credited to the Revenue Fund, as a first charge against same.

Section 11. INTEREST AND REDEMPTION FUND. That for the sole purpose of paying the principal of and interest on all Bonds and any Additional Bonds, as the same come due, either upon redemption or at maturity, there has been created and established, and there shall be maintained, at an official depository bank of the District, a separate fund to be entitled the "Tarrant Regional Water District Revenue Bonds Interest and Redemption Fund" (hereinafter called the "Interest and Redemption Fund").

Section 12. THE CONTINGENCY AND IMPROVEMENT FUND AND THE RESERVE FUND. (a) That there has been created and established and there shall be maintained, at an official depository bank of the District, a separate fund to be entitled the "Tarrant Regional Water District Water Revenue Bonds Contingency and Improvement Fund" (hereinafter called the "Contingency Fund"). The Contingency Fund shall be used solely for the purpose of paying the costs of improvements, enlargements, extensions, additions, or other capital expenditures relating to the System, and unexpected or extraordinary replacements of the System, for which System funds are not otherwise available, or for paying unexpected or extraordinary Operation and Maintenance Expenses of the System for which System Funds are not otherwise available, or for paying principal of and interest on any Bonds or Additional Bonds, when and to the extent the amount in the Interest and Redemption Fund is insufficient for such purpose.

(b) That there has been created and established and there shall be maintained at an official depository bank of the District, a separate fund to be entitled the "Tarrant Regional Water District Water Revenue Bonds Reserve Fund" (hereinafter called the "Reserve Fund"), solely for the further security and benefit of the Bonds and any Additional Bonds. The Reserve Fund shall be used solely for the purpose of (i) finally retiring the last of the Bonds and any Additional Bonds, and (ii) paying principal of and interest on the Bonds or any Additional Bonds when and to the extent the amounts in the Interest and Redemption Fund and Contingency Fund are insufficient for such purpose. Out of proceeds of the Bonds, there shall be deposited to the Reserve Fund an amount of money sufficient to cause the Reserve Fund to contain the Required Amount (hereinafter defined). When and so long as the money and investments in the Reserve Fund are not less in market value than a "Required Amount" equal to the principal and interest requirements of the Bonds during the fiscal year in which such requirements are scheduled to be the greatest, no deposits shall be made to the credit of the Reserve Fund; but when and if the Reserve Fund at any time thereafter contains less than said "Required Amount" in market value, then, subject and subordinate to making the required deposits to the credit of the Interest and Redemption Fund, the District shall transfer from Pledged Revenues and deposit to the credit of the Reserve Fund, semiannually on or before the 25th days of each February and each August of each year, a sum equal to 1/10th of the "Required Amount" until the Reserve Fund is restored to said "Required Amount." So long as the Reserve Fund contains said "Required Amount" in market value, all amounts in excess of said "Required Amount," if any, shall, at least annually, on or before the 25th day of February of each year, be deposited to the credit of the Interest and Redemption Fund.

Section 13. DEPOSITS OF PLEDGED REVENUES; INVESTMENTS. (a) That the Pledged Revenues shall be deposited into the Interest and Redemption Fund, the Reserve Fund, and the Contingency Fund, when and as required by this Bond Resolution, Sections 8 through 24 of which are cumulative of and supplemental to Sections 7 through 23 of the the Series 2006 Bond Resolution, and Sections 8 through 24 of the Series 2008A Bond Resolution, the Series 2008B Bond Resolution, the Series 2009 Bond Resolution, the Series 2010 Bond Resolution, the Series 2010A Bond Resolution, the Series 2010B Bond Resolution, the Series 2012 Bond Resolution, and the Series 2012A Bond Resolution, and Sections 8 through 24 of this Bond Resolution shall be applicable to all of the Bonds.

(b) That money in any Fund maintained pursuant to this Bond Resolution may, at the option of the District, be placed in time deposits or certificates of deposit secured by obligations of the type hereinafter described, or be invested in direct obligations of the United States of America, obligations guaranteed or insured by the United States of America, which, in the opinion of the Attorney General of the United States, are backed by its full faith and credit or represent its general obligations, or invested in indirect obligations of the United States of America, including, but not limited to, evidences of indebtedness issued, insured, or guaranteed by such governmental agencies as the Federal Land Banks, Federal Intermediate Credit Banks, Banks for Cooperatives, Federal Home Loan Banks, Government National Mortgage Association, United States Postal Service, Farmers Home Administration, Federal Home Loan Mortgage Association, Small Business Administration, Federal Housing Association, or Participation Certificates in the Federal Assets Financing Trust; provided that all such deposits and investments shall be made in such manner that the money required to be expended from any Fund will be available at the proper time or times. Such investments shall be valued by the District in terms of current market value as of the 20th day of February of each year. All interest and income derived from such deposits and investments immediately shall be credited to, and any losses debited to, the Fund from which the deposit or investment was made, and surpluses in any Fund shall be disposed of as herein provided. Such investments shall be sold promptly when necessary to prevent any default in connection with the Bonds or Additional Bonds.

Section 14. FUNDS SECURED. That money in all Funds described in this Bond Resolution shall be secured in the manner prescribed by law for securing funds of the District.

Section 15. DEBT SERVICE REQUIREMENTS. (a) That promptly after the delivery of the Initial Bond the District shall cause to be deposited to the credit of the Interest and Redemption Fund all accrued interest, if any, received from the sale and delivery of the Initial Bond, and any such deposit shall be used to pay part of the interest coming due on the Series 2014 Bonds.

(b) That the District shall transfer from the Pledged Revenues and deposit to the credit of the Interest and Redemption Fund the amounts, at the times, as follows:

(1) such amounts, deposited semiannually on or before the 25th day of each February and each August of each year, as will be sufficient, together with other amounts, if any, then on hand in the Interest and Redemption Fund and available for such purpose, to pay the interest scheduled to accrue and come due on all Bonds on the next succeeding interest payment date; and

(2) such amounts, deposited annually, on or before the 25th day of each February, as will be sufficient, together with other amounts, if any, then on hand in the Interest and Redemption Fund and available for such purpose, to pay all principal scheduled to mature and come due on all Bonds on the next succeeding March 1, and to pay all principal of all Bonds, if any, scheduled to be redeemed prior to maturity on the next succeeding March 1 in accordance with the mandatory redemption provisions and schedules set forth in any applicable Bond Resolution.

Section 16. CONTINGENCY REQUIREMENTS. That there is now on deposit to the credit of the Contingency Fund an amount equal to at least $1,100,000. No additional deposits are required to be made to the credit of the Contingency Fund unless and until such amount therein is reduced or depleted. If and when such amount in the Contingency Fund is reduced or depleted then, subject and subordinate to making the required deposits to the credit of the Interest and Redemption Fund and the Reserve Fund, such reduction or depletion shall be restored from amounts which shall be provided for such purpose in the District's Annual Budget for the next ensuing fiscal year or years; provided that the District is not required to budget more than $100,000 for such purpose during any one fiscal year; but the District shall have the right to budget additional amounts for such purpose if it is deemed necessary or advisable by the Board. So long as the Contingency Fund contains money and investments not less than the amount of $1,100,000 in market value, any surplus in the Contingency Fund over said amount shall, semiannually on or before February 15 and August 15 of each year, be withdrawn, deposited to the credit of the Revenue Fund, commingled with other revenues from the operation of the System, and used for any lawful purpose for which Gross Revenues of the System may be used.

Section 17. DEFICIENCIES; EXCESS PLEDGED REVENUES. (a) That if on any occasion there shall not be sufficient Pledged Revenues to make the required deposits into the Interest and Redemption Fund, the Reserve Fund, and the Contingency Fund, then such deficiency shall be made up as soon as possible from the next available Pledged Revenues, or from any other sources available for such purpose.

(b) That, subject to making the required deposits to the credit of the Interest and Redemption Fund, the Reserve Fund, and the Contingency Fund, when and as required by this Bond Resolution, or any resolution authorizing the issuance of Additional Bonds, the excess Pledged Revenues may be used for any lawful purpose.

Section 18. BONDS AND ADDITIONAL BONDS NOT PAYABLE FROM TAXES. It is specifically provided that the District is not authorized to, and shall not, levy, collect, or use any tax of any nature to pay the principal of or interest on any of the Bonds or Additional Bonds.

Section 19. PAYMENT OF BONDS AND ADDITIONAL BONDS. Semiannually on or before each March 1 and September 1 while any of the Bonds or Additional Bonds are outstanding and unpaid, the District shall make available to the paying agents therefor, ratably and on a parity out of the Interest and Redemption Fund, and/or the Contingency Fund, or, from the Reserve Fund, money sufficient to pay such interest on and such principal of the Bonds or Additional Bonds as will

accrue or mature, or which is scheduled to be redeemed prior to maturity, on each such March 1 and September 1, respectively. The paying agents shall destroy all paid Bonds or Additional Bonds, and the coupons, if any, appertaining thereto, and furnish the District with an appropriate certificate of cancellation or destruction.

Section 20. DEFEASANCE OF BONDS. (a) Any Bond and the interest thereon shall be deemed to be paid, retired, and no longer outstanding (a "Defeased Bond") within the meaning of this Resolution, except to the extent provided in subsection (d) of this Section, when payment of the principal of such Bond, plus interest thereon to the due date (whether such due date be by reason of maturity, or otherwise) either (i) shall have been made or caused to be made in accordance with the terms thereof or (ii) shall have been provided for on or before such due date by irrevocably depositing with or making available to the Paying Agent/Registrar in accordance with an escrow agreement or other instrument (the "Future Escrow Agreement") for such payment (1) lawful money of the United States of America sufficient to make such payment or (2) Defeasance Securities that mature as to principal and interest in such amounts and at such times as will insure the availability, without reinvestment, of sufficient money to provide for such payment, and when proper arrangements have been made by the Issuer with the Paying Agent/Registrar for the payment of its services until all Defeased Bonds shall have become due and payable. At such time as a Bond shall be deemed to be a Defeased Bond hereunder, as aforesaid, such Bond and the interest thereon shall no longer be secured by, payable from, or entitled to the benefits of, the revenues herein pledged as provided in this Resolution, and such principal and interest shall be payable solely from such money or Defeasance Securities. Notwithstanding any other provision of this Resolution to the contrary, it is hereby provided that any determination not to redeem Defeased Bonds that is made in conjunction with the payment arrangements specified in subsection 20(a)(i) or (ii) shall not be irrevocable, provided that: (1) in the proceedings providing for such payment arrangements, the Issuer expressly reserves the right to call the Defeased Bonds for redemption; (2) the Issuer gives notice of the reservation of that right to the owners of the Defeased Bonds immediately following the making of the payment arrangements, and (3) the Issuer directs that notice of the reservation be included in any redemption notices that it authorizes.

(b) Any moneys so deposited with the Paying Agent/Registrar may at the written direction of the Issuer also be invested in Defeasance Securities, maturing in the amounts and times as hereinbefore set forth, and all income from such Defeasance Securities received by the Paying Agent/Registrar that is not required for the payment of the Bonds and interest thereon, with respect to which such money has been so deposited, shall be turned over to the Issuer, or deposited as directed in writing by the Issuer. Any Future Escrow Agreement pursuant to which the money and/or Defeasance Securities are held for the payment of Defeased Bonds may contain provisions permitting the investment or reinvestment of such moneys in Defeasance Securities or the substitution of other Defeasance Securities upon the satisfaction of the requirements specified in subsection 20(a)(i) or (ii). All income from such Defeasance Securities received by the Paying Agent/Registrar which is not required for the payment of the Defeased Bonds, with respect to which such money has been so deposited, shall be remitted to the Issuer or deposited as directed in writing by the Issuer.

(c) The term "Defeasance Securities" means (i) direct, noncallable obligations of the United States of America, including obligations that are unconditionally guaranteed by the United

States of America, (ii) noncallable obligations of an agency or instrumentality of the United States of America, including obligations that are unconditionally guaranteed or insured by the agency or instrumentality and that, on the date of the purchase thereof are rated as to investment quality by a nationally recognized investment rating firm not less than AAA or its equivalent, and (iii) noncallable obligations of a state or an agency or a county, municipality, or other political subdivision of a state that have been refunded and that, on the date the governing body of the Issuer adopts or approves the proceedings authorizing the financial arrangements are rated as to investment quality by a nationally recognized investment rating firm not less than AAA or its equivalent.

(d) Until all Defeased Bonds shall have become due and payable, the Paying Agent/Registrar shall perform the services of Paying Agent/Registrar for such Defeased Bonds the same as if they had not been defeased, and the Issuer shall make proper arrangements to provide and pay for such services as required by this Resolution.

(e) In the event that the Issuer elects to defease less than all of the principal amount of Bonds of a maturity, the Paying Agent/Registrar shall select, or cause to be selected, such amount of Bonds by such random method as it deems fair and appropriate.

Section 21. ADDITIONAL BONDS. (a) That the District shall have the right and power at any time and from time to time, and in one or more Series or issues, to authorize, issue, and deliver additional bonds (herein called "Additional Bonds"), which may be payable from and secured by a first lien on and pledge of the Pledged Revenues. No Additional Bonds shall be payable from or secured by ad valorem or other taxes.

(b) Additional Bonds, if and when authorized, issued, and delivered in accordance with the provisions hereof, shall be payable from the Interest and Redemption Fund, and shall be payable from and secured by a first lien on and pledge of the Pledged Revenues, equally and ratably on a parity with the Bonds and all other outstanding Additional Bonds.

(c) That the principal of all Additional Bonds must be scheduled to be paid or mature on March 1 of the years in which such principal is scheduled to be paid or mature; and all interest thereon must be payable on March 1 and September 1.

Section 22. FURTHER REQUIREMENTS FOR ADDITIONAL BONDS. (a) That Additional Bonds shall be issued only in accordance with the provisions hereof, and then applicable laws, and may be issued in any amounts, for any lawful purpose relating to the System, including the refunding of any Bonds or Additional Bonds. No installment, Series, or issue of Additional Bonds shall be issued or delivered unless the President and the Secretary of the Board sign a written certificate to the effect (i) that the District is not in default as to any covenant, condition, or obligation in connection with all outstanding Bonds and Additional Bonds, and the resolutions authorizing the same, (ii) that the Interest and Redemption Fund and the Reserve Fund contain the amount then required to be therein, and (iii) that either (1) the Pledged Revenues in each fiscal year, commencing (A) with the third complete fiscal year following the execution of such certificate or report, or (B) with the fiscal year following the estimated completion date of any project for which the then proposed Additional Bonds are being issued (whichever of (A) or (B) is later) are estimated, based on a report of an independent engineer or firm of engineers, to be at least equal to 1.25 times

the average annual principal and interest requirements of all Bonds and Additional Bonds to be outstanding after delivery of the then proposed Additional Bonds, or (2) based upon an opinion of legal counsel to the District, there are Contracts then in effect pursuant to which parties to such Contracts are obligated to make minimum payments to the District on a "take or pay" basis at such times and in such amounts as shall be necessary to provide to the District Pledged Revenues sufficient to pay when due all principal of and interest on all Bonds and Additional Bonds.

(b) That each resolution authorizing the issuance of Additional Bonds shall confirm the Reserve Fund as additional security for all such Additional Bonds, and the Reserve Fund shall be increased to the extent required to cause the Reserve Fund to be maintained in an amount not less than the principal and interest requirements, during the fiscal year in which such requirements are scheduled to be the greatest, of all Bonds and Additional Bonds to be outstanding after the issuance of such then proposed Additional Bonds (or any greater amount as may, at the option of the District, be provided for in any resolution authorizing the issuance of any Additional Bonds), and shall make provision for funding such Reserve Fund from Pledged Revenues, or, at the option of the District, from bond proceeds or other available sources. Such Reserve Fund may be funded in whole or in part initially, or may be funded in whole or in part from Pledged Revenues by approximately equal periodic payments, not less than annual, and within not more than five years from the date of such then proposed Additional Bonds.

(c) That all calculations of principal and interest requirements of any bonds made in connection with the issuance of any then proposed Additional Bonds shall be made as of the date of such Additional Bonds; and also in making calculations for such purpose, or for any other purpose under any resolution authorizing any Bonds or Additional Bonds, the principal amounts of any Bonds or Additional Bonds which must be redeemed prior to maturity pursuant to any applicable mandatory redemption requirements shall be deemed to be maturing amounts of principal.

Section 23. GENERAL COVENANTS, REPRESENTATIONS, AND WARRANTIES. That the District further covenants, represents, warrants, and agrees that:

(a) PERFORMANCE. It will faithfully perform at all times any and all covenants, undertakings, stipulations, and provisions contained in each resolution authorizing the issuance of the Bonds and any Additional Bonds, and in each and every Bond and Additional Bond; that it will promptly pay or cause to be paid the principal of and interest on every Bond and Additional Bond, on the dates and in the places and manner prescribed in such resolutions and Bonds or Additional Bonds, and that it will, at the times and in the manner prescribed, deposit or cause to be deposited the amounts required to be deposited into the Interest and Redemption Fund; and any holder of the Bonds or Additional Bonds may require the District, its Board, and its officials and employees, to carry out, respect, or enforce the covenants and obligations of each resolution authorizing the issuance of the Bonds and any Additional Bonds, by all legal and equitable means, including specifically, but without limitation, the use and filing of mandamus proceedings, in any court of competent jurisdiction, against the District, its Board, and its officials and employees.

(b) DISTRICT'S LEGAL AUTHORITY. It is a duly created and existing conservation and reclamation district of the State of Texas pursuant to Article 16, Section 59, of the Texas Constitution, and the laws of the State of Texas, and is duly authorized under the laws of the State of Texas to create and issue the Bonds; that all action on its part for the creation and issuance of the

Bonds has been duly and effectively taken, and that the Bonds in the hands of the holders and owners thereof are and will be valid and enforceable obligations of the District in accordance with their terms.

(c) TITLE. It has acquired and constructed, and will operate and maintain the System, and has or will obtain lawful title to, or the lawful right to use and operate, the lands, buildings, and facilities constituting the System, that it warrants that it will defend the title to or lawful right to use and operate, all of the aforesaid lands, buildings, and facilities, and every part thereof, for the benefit of the holders and owners of the Bonds and Additional Bonds against the claims and demands of all persons whomsoever, and is lawfully qualified to pledge the Pledged Revenues to the payment of the Bonds and Additional Bonds in the manner prescribed herein, and has lawfully exercised such rights.

(d) LIENS. It will from time to time and before the same become delinquent pay and discharge all taxes, assessments, and governmental charges, if any, which shall be lawfully imposed upon it, or the System, that it will pay all lawful claims for rents, royalties, labor, materials, and supplies which if unpaid might by law become a lien or charge thereon, the lien of which would be prior to or interfere with the liens hereof, so that the priority of the liens granted hereunder shall be fully preserved in the manner provided herein, and that it will not create or suffer to be created any mechanic's, laborer's, materialman's, or other lien or charge which might or could be prior to the liens hereof, or do or suffer any matter or thing whereby the liens hereof might or could be impaired; provided, however, that no such tax, assessment, or charge, and that no such claims which might be used as the basis of a mechanic's, laborer's, materialman's, or other lien or charge, shall be required to be paid so long as the validity of the same shall be contested in good faith by the District.

(e) OPERATION OF THE SYSTEM. While the Bonds or any Additional Bonds are outstanding and unpaid it will cause the System to be continuously and efficiently operated and maintained in good condition, repair, and working order, and at a reasonable cost.

(f) FURTHER ENCUMBRANCE. While the Bonds or any Additional Bonds are outstanding and unpaid, it will not additionally encumber the Pledged Revenues in any manner, except as permitted hereby in connection with Additional Bonds, unless said encumbrance is made junior and subordinate in all respects to the liens, pledges, covenants, and agreements of each resolution authorizing the issuance of the Bonds and any Additional Bonds; but the right of the District and the Board to issue revenue bonds for any lawful purpose payable from a subordinate lien on the Pledged Revenues is specifically recognized and retained. This Resolution does not and is not intended to affect, limit, or prohibit the issuance of bonds payable solely from ad valorem taxes.

(g) SALE OF PROPERTY. While the Bonds or any Additional Bonds, are outstanding and unpaid, it will maintain its current legal corporate status as a conservation and reclamation district, and it will not sell, convey, mortgage, or in any manner transfer title to, or lease or otherwise dispose of the entire System, or any significant or substantial part thereof; provided that whenever the District deems it necessary to dispose of any real or personal property, machinery, fixtures, or equipment, it may sell or otherwise dispose of such real or personal property, machinery, fixtures, or equipment when it has made arrangements to replace the same or provide substitutes therefor, unless it is determined by resolution of the Board that no such replacement or substitute is necessary; and all proceeds from the sale thereof shall be credited to the Revenue Fund. In all events counsel

to the Issuer shall opine as to the validity of the Resolution, as supplemented and amended and counsel to the Contracting Parties shall opine on the validity of the obligation of the Contracting Parties under the Contract.

(h) INSURANCE. (1) It will carry or cause to be carried such insurance as usually would be carried by corporations or other business entities operating like properties and engaged in similar activities, with a responsible insurance company or companies; provided that no insurance shall be required to the extent that the Board determines, based on the advise of legal counsel, that no substantial liability can or will arise under a particular hazard. At any time while any contractor engaged in construction work shall be fully responsible therefor, the District shall not be required to carry insurance on the works being constructed, if the contractor is required to carry appropriate insurance. All such policies shall be open to the inspection of the owners or holders of the Bonds and Additional Bonds and their representatives at all reasonable times.

(2) Upon the happening of any loss or damage covered by insurance from one or more of said causes, the District shall make due proof of loss and shall do all things necessary or desirable to cause the insuring companies to make payment in full directly to the District. The proceeds of insurance covering such property, together with any other funds necessary and available for such purpose, shall be used forthwith by the District for repairing the property damaged or replacing the property destroyed; provided, however, that if said insurance proceeds and other funds are insufficient for such purpose, then said insurance proceeds pertaining to the System shall be used promptly as follows:

(a) for the redemption prior to maturity of the Bonds and Additional Bonds, if any, ratably in the proportion that the outstanding principal of each Series or issue of Bonds or Additional Bonds bears to the total outstanding principal of all Bonds and Additional Bonds; provided that if on any such occasion the principal of any such Series or issue is not subject to redemption, it shall not be regarded as outstanding in making the foregoing computation; or

(b) if none of the outstanding Bonds or Additional Bonds is subject to redemption, then for the purchase on the open market and retirement of said Bonds and Additional Bonds, in the same proportion as prescribed in the foregoing clause (a), to the extent practicable; provided that the purchase price for any such Bond or Additional Bonds shall not exceed the redemption price of such Bond or Additional Bond on the first date upon which it becomes subject to redemption; or

(c) to the extent that the foregoing clauses (a) and (b) cannot be complied with at the time, the insurance proceeds, or the remainder thereof, shall be deposited in a special and separate trust fund, at an official depository of the District, to be designated the Insurance Account. The Insurance Account shall be held until such time as the foregoing clauses (a) and/or (b) can be complied with, or until other funds become available which, together with the Insurance Account, will be sufficient to make the repairs or replacements originally required, whichever of said events occurs first.

(3) The annual audit hereinafter required shall contain a list of all such insurance policies carried, together with a statement as to whether or not all insurance premiums upon such policies have been paid.

(i) RATE COVENANT. It will fix, establish, maintain, revise (if and when necessary), and collect such rates, charges, and fees for the sale of water from the System and for the use and availability of the System as are necessary to produce Gross Revenues of the System sufficient, together with any other Pledged Revenues and any taxes as may be levied by the District for such purpose, (1) to pay all Operation and Maintenance Expenses of the System, and (2) to produce Pledged Revenues adequate to provide for all payments and deposits required to be made into the Interest and Redemption Fund, the Reserve Fund, and the Contingency Fund, when and as required by the resolutions authorizing all Bonds and Additional Bonds.

(j) RECORDS. It will keep proper books of records and accounts in which full, true, and correct entries will be made of all dealings, activities, and transactions relating to the System, the Pledged Revenues, and all Funds created pursuant to each resolution authorizing the issuance of the Bonds and Additional Bonds; and all books, documents, and vouchers relating thereto shall at all reasonable times be made available for inspection upon request of any bondholder.

(k) AUDITS. Each year while any of the Bonds or Additional Bonds are outstanding, an audit will be made of its books and accounts relating to the System and the Pledged Revenues by an independent certified public accountant or an independent firm of certified public accountants. As soon as practicable after the close of each year, and when said audit has been completed and made available to the District, a copy of such audit for the preceding year shall be mailed to the Municipal Advisory Council of Texas and to any bondholders who shall so request in writing. Such annual audit reports shall be open to the inspection of the owners or holders of the Bonds and Additional Bonds and their agents and representatives at all reasonable times.

(l) GOVERNMENTAL AGENCIES. It will comply with all of the terms and conditions of any and all franchises, permits, and agreements applicable to the System and the Bonds or Additional Bonds entered into between the District and any governmental agency, and the District will take all action necessary to enforce said terms and conditions; and the District will obtain and keep in full force and effect all franchises, permits, and other requirements necessary with respect to the acquisition, construction, operation, and maintenance of the System.

(m) CONTRACTS. It will comply with the terms and conditions of the Contracts and will cause the other parties to the Contracts to comply with all of their obligations thereunder by all lawful means; and the Contracts will not be rescinded, modified, or amended in any way which would have a materially adverse effect on the operation of the System or the rights of the owners of the Bonds and Additional Bonds.

(n) ANNUAL BUDGET. On or before August 1 of each calendar year, it will prepare the preliminary Annual Budget of Operation and Maintenance Expenses of the System for the ensuing fiscal year, and such budget shall include a showing as to the proposed expenditures for such ensuing fiscal year, and shall show the estimated amount of Net Revenues of the System for such year. If the owners or holders of 25% in aggregate principal amount of the Bonds and

Additional Bonds then outstanding shall so request on or before the 15th day of the aforesaid month, the Board shall hold a public hearing on or before the 15th day of the following month, at which any bondholder may appear in person or by agent or attorney and present any objections he may have to the final adoption of such budget. Notice of the time and place of such hearing shall be published twice, once in each of two successive weeks, in a newspaper of general circulation published in the District, with the date of the first publication to be at least fourteen days before the date fixed for the hearing; and copies of such notice shall be mailed at least ten days before the hearing to each bondholder who shall have filed his name and address with the Secretary of the Board for such purpose. The District further covenants that on or before October 1 of each calendar year it will finally adopt the Annual Budget of Operation and Maintenance Expenses of the System for such fiscal year (hereinafter sometimes called the "Annual Budget"). If for any reason the Board shall not have adopted the Annual Budget before the first day of any fiscal year, the budget for the preceding fiscal year shall be deemed to be in force until the adoption of the Annual Budget. The Operation and Maintenance Expenses of the System incurred in any fiscal year will not exceed the reasonable and necessary amount thereof. The District may, at any time deemed necessary by the Board, adopt an Amended or Supplemental Budget for the remainder of the then current fiscal year.

Section 24. AMENDMENT OF RESOLUTION. (a) The holders and registered owners of Bonds and Additional Bonds (hereinafter collectively called "holders") aggregating 51% in principal amount of the aggregate principal amount of then outstanding Bonds and Additional Bonds shall have the right from time to time to approve any amendment to any resolution authorizing the issuance of any Bonds or Additional Bonds, which may be deemed necessary or desirable by the District, provided, however, that nothing herein contained shall permit or be construed to permit the amendment of the terms and conditions in said resolutions or in the Bonds or Additional Bonds so as to:

(1) Make any change in the maturity of the outstanding Bonds or Additional Bonds;

(2) Reduce the rate of interest borne by any of the outstanding Bonds or Additional Bonds;

(3) Reduce the amount of the principal payable on the outstanding Bonds or Additional Bonds;

(4) Modify the terms of payment of principal of or interest on the outstanding Bonds or Additional Bonds, or impose any conditions with respect to such payment;

(5) Effect any change in the rights of the holders of the Bonds and Additional Bonds then outstanding, other than a change which similarly affects all such holders;

(6) Change the minimum percentage of the principal amount of Bonds and Additional Bonds necessary for consent to such amendment.

(b) If at any time the District shall desire to amend a resolution under this Section, the District shall cause notice of the proposed amendment to be published in a financial newspaper or

journal published in The City of New York, New York, once during each calendar week for at least two successive calendar weeks. Such notice shall briefly set forth the nature of the proposed amendment and shall state that a copy thereof is on file at the principal office of each Paying Agent/Registrar for the Bonds and Additional Bonds, for inspection by all holders of Bonds and Additional Bonds. Such publication is not required, however, if notice in writing is given to each holder of Bonds and Additional Bonds.

(c) Whenever at any time not less than thirty days, and within one year, from the date of the first publication of said notice or other service of written notice the District shall receive an instrument or instruments executed by the holders of at least 51% in aggregate principal amount of all Bonds and Additional Bonds then outstanding, which instrument or instruments shall refer to the proposed amendment described in said notice and which specifically consent to and approve such amendment in substantially the form of the copy thereof on file as aforesaid, the District may adopt the amendatory resolution in substantially the same form.

(d) Upon the adoption of any amendatory resolution pursuant to the provisions of this Section, the resolution being amended shall be deemed to be amended in accordance with the amendatory resolution, and the respective rights, duties, and obligations of the District and all the holders of then outstanding Bonds and Additional Bonds and all future Additional Bonds shall thereafter be determined, exercised, and enforced hereunder, subject in all respects to such amendment.

(e) Any consent given by the holder of a Bond or Additional Bonds pursuant to the provisions of this Section shall be irrevocable for a period of six months from the date of the first publication of the notice provided for in this Section, and shall be conclusive and binding upon all future holders of the same Bond or Additional Bond during such period. Such consent may be revoked at any time after six months from the date of the first publication of such notice by the holder who gave such consent, or by a successor in title, by filing notice thereof with each Paying Agent/Registrar for the Bonds and Additional Bonds, and the District, but such revocation shall not be effective if the holders of 51% in aggregate principal amount of the then outstanding Bonds and Additional Bonds as in this Section defined have, prior to the attempted revocation, consented to and approved the amendment.

(f) For the purpose of this Section, the fact of the holding of Bonds or Additional Bonds by any holder of Bonds or Additional Bonds which are not registered and which are payable to bearer, and the amount and numbers of such registered Bonds and Additional Bonds, and the date of their holding same, may be provided by the affidavit of the person claiming to be such holder, or by a certificate executed by any trust company, bank, banker, or any other depository wherever situated showing that at the date therein mentioned such person had on deposit with such trust company, bank, banker, or other depository, the Bonds or Additional Bonds described in such certificate. The District may conclusively assume that such ownership continues until written notice to the contrary is served upon the District. All matters relating to the ownership of registered Bonds and Additional Bonds shall be determined from the bond registration books kept by the registrar therefor.

Section 25. DAMAGED, MUTILATED, LOST, STOLEN, OR DESTROYED Series 2014 BONDS. (a) Replacement Bonds. In the event any outstanding Series 2014 Bond is damaged, mutilated, lost, stolen, or destroyed, the Paying Agent/Registrar shall cause to be printed, executed, and delivered, a new bond of the same principal amount, maturity, and interest rate, as the damaged, mutilated, lost, stolen, or destroyed Bond, in replacement for such Series 2014 Bond in the manner hereinafter provided.

(b) Application for Replacement Bonds. Application for replacement of damaged, mutilated, lost, stolen, or destroyed Series 2014 Bonds shall be made by the registered owner thereof to the Paying Agent/Registrar. In every case of loss, theft, or destruction of a Series 2014 Bond, the registered owner applying for a replacement bond shall furnish to the Issuer and to the Paying Agent/Registrar such security or indemnity as may be required by them to save each of them harmless from any loss or damage with respect thereto. Also, in every case of loss, theft, or destruction of a Series 2014 Bond, the registered owner shall furnish to the Issuer and to the Paying Agent/Registrar evidence to their satisfaction of the loss, theft, or destruction of such Series 2014 Bond, as the case may be. In every case of damage or mutilation of a Series 2014 Bond, the registered owner shall surrender to the Paying Agent/Registrar for cancellation the Series 2014 Bond so damaged or mutilated.

(c) No Default Occurred. Notwithstanding the foregoing provisions of this Section, in the event any such Series 2014 Bond shall have matured, and no default has occurred which is then continuing in the payment of the principal of, redemption premium, if any, or interest on the Series 2014 Bond, the Issuer may authorize the payment of the same (without surrender thereof except in the case of a damaged or mutilated Series 2014 Bond) instead of issuing a replacement Series 2014 Bond, provided security or indemnity is furnished as above provided in this Section.

(d) Charge for Issuing Replacement Bonds. Prior to the issuance of any replacement bond, the Paying Agent/Registrar shall charge the registered owner of such Series 2014 Bond with all legal, printing, and other expenses in connection therewith. Every replacement bond issued pursuant to the provisions of this Section by virtue of the fact that any Series 2014 Bond is lost, stolen, or destroyed shall constitute a contractual obligation of the Issuer whether or not the lost, stolen, or destroyed Series 2014 Bond shall be found at any time, or be enforceable by anyone, and shall be entitled to all the benefits of this Resolution equally and proportionately with any and all other Series 2014 Bonds duly issued under this Resolution.

(e) Authority for Issuing Replacement Bonds. In accordance with Chapter 1201, Texas Government Code, this Section of this Resolution shall constitute authority for the issuance of any such replacement bond without necessity of further action by the governing body of the Issuer or any other body or person, and the duty of the replacement of such bonds is hereby authorized and imposed upon the Paying Agent/Registrar, and the Paying Agent/Registrar shall authenticate and deliver such Series 2014 Bonds in the form and manner and with the effect, as provided in this Resolution for Series 2014 Bonds issued in conversion and exchange for other Series 2014 Bonds.

Section 26. CUSTODY, APPROVAL, AND REGISTRATION OF SERIES 2014 BONDS; BOND COUNSEL'S OPINION, CUSIP NUMBERS, PREAMBLE, AND INSURANCE. The President of the Board of Directors of the Issuer is hereby authorized to have control of the

Initial Bond issued hereunder and all necessary records and proceedings pertaining to said Initial Bond pending its delivery and its investigation, examination, and approval by the Attorney General of the State of Texas, and its registration by the Comptroller of Public Accounts of the State of Texas. Upon registration of said Initial Bond said Comptroller of Public Accounts (or a deputy designated in writing to act for said Comptroller) shall manually sign the Comptroller's Registration Certificate on said Initial Bond, and the seal of said Comptroller shall be impressed, or placed in facsimile, on said Initial Bond. The approving legal opinion of the Issuer's Co-Bond Counsel and the assigned CUSIP numbers may, at the option of the Issuer, be printed on said Initial Bond or on any Series 2014 Bonds issued and delivered in conversion of and exchange or replacement of any Series 2014 Bond, but neither shall have any legal effect, and shall be solely for the convenience and information of the registered owners of the Series 2014 Bonds. The preamble to this Resolution is hereby adopted and made a part hereof for all purposes. If insurance is obtained by the Underwriter (as defined in Section 31 hereof) on any of the Series 2014 Bonds, the Initial Bond and all the Series 2014 Bonds so insured shall bear an appropriate legend concerning insurance as provided by the insurer.

Section 27. COVENANTS REGARDING TAX EXEMPTION. (a) Covenants. The Issuer covenants to take any action necessary to assure, or refrain from any action that would adversely affect, the treatment of the Series 2014 Bonds as obligations described in section 103 of the Internal Revenue Code of 1986, as amended (the "Code"), the interest on which is not includable in the "gross income" of the Series 2014 Bonds holder for purposes of federal income taxation. In furtherance thereof, the Issuer covenants as follows:

(1) to take any action to assure that no more than 10 percent of the proceeds of the Series 2014 Bonds (less amounts deposited to a reserve fund, if any) are used for any "private business use," as defined in section 141(b)(6) of the Code or, if more than 10 percent of the proceeds or the projects financed therewith are so used, such amounts, whether or not received by the Issuer, with respect to such private business use, do not, under the terms of this Resolution or any underlying arrangement, directly or indirectly, secure or provide for the payment of more than 10 percent of the debt service on the Series 2014 Bonds, in contravention of section 141(b)(2) of the Code;

(2) to take any action to assure that in the event that the "private business use" described in subsection (1) hereof exceeds 5 percent of the proceeds of the Series 2014 Bonds or the projects financed therewith (less amounts deposited into a reserve fund, if any) then the amount in excess of 5 percent is used for a "private business use" that is "related" and not "disproportionate," within the meaning of section 141(b)(3) of the Code, to the governmental use;

(3) to take any action to assure that no amount that is greater than the lesser of $5,000,000, or 5 percent of the proceeds of the Series 2014 Bonds (less amounts deposited into a reserve fund, if any) is directly or indirectly used to finance loans to persons, other than state or local governmental units, in contravention of section 141(c) of the Code;

(4) to refrain from taking any action that would otherwise result in the Series 2014 Bonds being treated as "private activity bonds" within the meaning of section 141(b) of the Code;

(5) to refrain from taking any action that would result in the Series 2014 Bonds being "federally guaranteed" within the meaning of section 149(b) of the Code;

(6) to refrain from using any portion of the proceeds of the Series 2014 Bonds, directly or indirectly, to acquire or to replace funds that were used, directly or indirectly, to acquire investment property (as defined in section 148(b)(2) of the Code) that produces a materially higher yield over the term of the Series 2014 Bonds, other than investment property acquired with –

(A) proceeds of the Series 2014 Bonds invested for a reasonable temporary period of 3 years or less or, in the case of a refunding bond, for a period of 90 days or less until such proceeds are needed for the purpose for which the Series 2014 Bonds are issued,

(B) amounts invested in a bona fide debt service fund, within the meaning of section 1.148-1(b) of the Treasury Regulations, and

(C) amounts deposited in any reasonably required reserve or replacement fund to the extent such amounts do not exceed 10 percent of the proceeds of the Series 2014 Bonds;

(7) to otherwise restrict the use of the proceeds of the Series 2014 Bonds or amounts treated as proceeds of the Series 2014 Bonds, as may be necessary, so that the Series 2014 Bonds do not otherwise contravene the requirements of section 148 of the Code (relating to arbitrage) and, to the extent applicable, section 149(d) of the Code (relating to advance refundings);

(8) to pay to the United States of America at least once during each five-year period (beginning on the date of delivery of the Series 2014 Bonds) an amount that is at least equal to 90 percent of the "Excess Earnings," within the meaning of section 148(f) of the Code and to pay to the United States of America, not later than 60 days after the Series 2014 Bonds have been paid in full, 100 percent of the amount then required to be paid as a result of Excess Earnings under section 148(f) of the Code; and

(b) Rebate Fund. In order to facilitate compliance with the above covenant (a)(8), a "Rebate Fund" is hereby established by the Issuer for the sole benefit of the United States of America, and such Fund shall not be subject to the claim of any other person, including without limitation the Bondholders. The Rebate Fund is established for the additional purpose of compliance with section 148 of the Code.

(c) Compliance with Code. For purposes of the foregoing covenants (a)(1) and (a)(2), the Issuer understands that the term "proceeds" includes "disposition proceeds" as defined in the Treasury Regulations and, in the case of refunding Series 2014 Bonds, transferred proceeds (if any) and proceeds of the refunded Series 2014 Bonds expended prior to the date of issuance of the refunding Series 2014 Bonds. It is the understanding of the Issuer that the covenants contained herein are intended to assure compliance with the Code and any regulations or rulings promulgated by the U.S. Department of the Treasury pursuant thereto. In the event that regulations or rulings are hereafter promulgated that modify or expand provisions of the Code, as applicable to the Series 2014 Bonds, the Issuer will not be required to comply with any covenant contained herein to the extent that such failure to comply, in the opinion of nationally recognized bond counsel, will not adversely affect the exemption from federal income taxation of interest on the Series 2014 Bonds under section 103 of the Code. In the event that regulations or rulings are hereafter promulgated that impose additional requirements applicable to the Series 2014 Bonds, the Issuer agrees to comply with the additional requirements to the extent necessary, in the opinion of nationally recognized bond counsel, to preserve the exemption from federal income taxation of interest on the Series 2014 Bonds under section 103 of the Code. In furtherance of such intention, the Issuer hereby authorizes and directs the President of the Board of Directors, the General Manager, or the Director of Finance to execute any documents, certificates or reports required by the Code and to make such elections, on behalf of the Issuer, that may be permitted by the Code as are consistent with the purpose for the issuance of the Series 2014 Bonds.

(d) Written Procedures. Unless superseded by another action of the Issuer to ensure compliance with the covenants contained herein regarding private business use, remedial actions, arbitrage and rebate, the Issuer hereby adopts and establishes the instructions attached hereto as Exhibit A as their written procedures applicable to the Bonds and any Additional Bonds.

Section 28. ALLOCATION OF, AND LIMITATION ON, EXPENDITURES FOR THE PROJECT. The Issuer covenants to account for the expenditure of sale proceeds and investment earnings to be used for the purposes described in Section 1 of this Resolution (the "Project") on its books and records by allocating proceeds to expenditures within 18 months of the later of the date that (1) the expenditure is made, or (2) the Project is completed. The foregoing notwithstanding, the Issuer shall not expend sale proceeds or investment earnings thereon more than 60 days after the earlier of (1) the fifth anniversary of the delivery of the Series 2014 Bonds, or (2) the date the Series 2014 Bonds are retired, unless the Issuer obtains an opinion of nationally-recognized bond counsel that such expenditure will not adversely affect the tax-exempt status of the Series 2014 Bonds. For purposes hereof, the Issuer shall not be obligated to comply with this covenant if it obtains an opinion that such failure to comply will not adversely affect the excludability for federal income tax purposes from gross income of the interest.

Section 29. DISPOSITION OF PROJECT. The Issuer covenants that the property constituting the Project refinanced by the Series 2014 Bonds will not be sold or otherwise disposed in a transaction resulting in the receipt by the Issuer of cash or other compensation, unless the Issuer obtains an opinion of nationally-recognized bond counsel that such sale or other disposition will not adversely affect the tax-exempt status of the Series 2014 Bonds. For purposes of the foregoing, the portion of the property comprising personal property and disposed in the ordinary course shall not be treated as a transaction resulting in the receipt of cash or other compensation. For purposes

hereof, the Issuer shall not be obligated to comply with this covenant if it obtains an opinion that such failure to comply will not adversely affect the excludability for federal income tax purposes from gross income of the interest.

Section 30. CONTINUING DISCLOSURE. (a) Definitions. As used in this Section, the following terms have the meanings ascribed to such terms below:

"*Authority*" means Trinity River Authority.

"*Cities*" means the Cities of Arlington, Fort Worth and Mansfield.

"*MSRB*" means the Municipal Securities Rulemaking Board.

"*Rule*" means SEC Rule 15c2-12, as amended from time to time.

"*SEC*" means the United States Securities and Exchange Commission.

(b) General. Pursuant to a Continuing Disclosure Agreement by and among the Issuer, the Cities, and the Authority, the Issuer, the Cities and the Authority have undertaken for the benefit of the beneficial owners of the Series 2014 Bonds, to the extent set forth therein, to provide continuing disclosure of financial information and operating data with respect to the Issuer, Cities and Authority in accordance with the Rule as promulgated by the SEC.

(c) Annual Reports. (i) The Issuer shall provide annually to the MSRB, within six months after the end of each fiscal year ending in or after 2014, financial information and operating data with respect to the Issuer of the general type included in the final Official Statement authorized by Section 32 of this Resolution, being the information described in Exhibit B. Any financial statements so to be provided shall be prepared in accordance with the accounting principles described in Exhibit B thereto, or such other accounting principles as the Issuer may be required to employ from time to time pursuant to state law or regulation, and audited, if the Issuer commissions an audit of such statements and the audit is completed within the period during which they must be provided. If the audit of such financial statements is not complete within such period, then the Issuer shall provide audited financial statements for the applicable fiscal year to each NRMSIR and any SID, when and if the audit report on such statements become available.

(ii) If the Issuer changes its fiscal year, it will notify the MSRB of the change (and of the date of the new fiscal year end) prior to the next date by which the Issuer otherwise would be required to provide financial information and operating data pursuant to this Section. The financial information and operating data to be provided pursuant to this Section may be set forth in full in one or more documents or may be included by specific reference to any document (including an official statement or other offering document, if it is available from the MSRB) that theretofore has been provided to the MSRB, or filed with the SEC.

(d) Disclosure Event Notices. The Issuer shall notify the MSRB, in a timely manner, of any of the following events with respect to the Series 2014 Bonds, not in excess of ten Business Days after occurrence of the event:

1. Principal and interest payment delinquencies;

2. Non-payment related defaults, if material;

3. Unscheduled draws on debt service reserves reflecting financial difficulties;

4. Unscheduled draws on credit enhancements reflecting financial difficulties;

5. Substitution of credit or liquidity providers, or their failure to perform;

6. Adverse tax opinions, the issuance by the Internal Revenue Service of proposed or final determinations of taxability, Notices of Proposed Issue (IRS Form 5701-TEB) or other material notices or determinations with respect to the tax status of the security, or other material events affecting the tax status of the security;

7. Modifications to the rights of security holders, if material;

8. Bond calls, if material, and tender offers;

9. Defeasances;

10. Release, substitution or sale of property securing repayment of the securities, if material;

11. Rating changes;

12. Bankruptcy, insolvency, receivership or similar event of the Issuer, any of the Cities or the Authority;

13. The consummation of a merger, consolidation, or acquisition involving the Issuer or the sale of all or substantially all of the assets of the Issuer, any of the Cities, or the Authority, other than in the ordinary course of business, the entry into a definitive agreement to undertake such an action or the termination of a definitive agreement relating to any such actions, other than pursuant to its terms, if material; and

14. Appointment of a successor or additional trustee or the change of name of a trustee, if material.

The Issuer shall notify the MSRB, in a timely manner, of any failure by the Issuer to provide financial information or operating data in accordance with Section 30(c) of this Resolution by the time required by such Section. As used in clause 12 above, the phrase "bankruptcy, insolvency, receivership or similar event" means the appointment of a receiver, fiscal agent, or similar officer for the Issuer in a proceeding under the U.S. Bankruptcy Code or in any other proceeding under state or federal law in which a court or governmental authority has assumed jurisdiction over substantially all of the assets or business of the Issuer, or if jurisdiction has been assumed by leaving the Board

of Directors and official or officers of the Issuer in possession but subject to the supervision and orders of a court or governmental authority, or the entry of an order confirming a plan of reorganization, arrangement or liquidation by a court or governmental authority having supervision or jurisdiction over substantially all of the assets or business of the Issuer.

(e) Limitations, Disclaimers, and Amendments. (i) The Issuer shall be obligated to observe and perform the covenants specified in this Section for so long as, but only for so long as, the Issuer remains an "obligated person" with respect to the Series 2014 Bonds within the meaning of the Rule, except that the Issuer in any event will give notice of any deposit made in accordance with this Resolution or applicable law that causes Series 2014 Bonds no longer to be outstanding.

(ii) The provisions of this Section are for the sole benefit of the holders and beneficial owners of the Series 2014 Bonds, and nothing in this Section, express or implied, shall give any benefit or any legal or equitable right, remedy, or claim hereunder to any other person. The Issuer undertakes to provide only the financial information, operating data, financial statements, and notices which it has expressly agreed to provide pursuant to this Section and does not hereby undertake to provide any other information that may be relevant or material to a complete presentation of the Issuer's financial results, condition, or prospects or hereby undertake to update any information provided in accordance with this Section or otherwise, except as expressly provided herein. The Issuer does not make any representation or warranty concerning such information or its usefulness to a decision to invest in or sell Series 2014 Bonds at any future date.

(iii) UNDER NO CIRCUMSTANCES SHALL THE ISSUER BE LIABLE TO THE HOLDER OR BENEFICIAL OWNER OF ANY SERIES 2014 BOND OR ANY OTHER PERSON, IN CONTRACT OR TORT, FOR DAMAGES RESULTING IN WHOLE OR IN PART FROM ANY BREACH BY THE ISSUER, WHETHER NEGLIGENT OR WITHOUT FAULT ON ITS PART, OF ANY COVENANT SPECIFIED IN THIS SECTION, BUT EVERY RIGHT AND REMEDY OF ANY SUCH PERSON, IN CONTRACT OR TORT, FOR OR ON ACCOUNT OF ANY SUCH BREACH SHALL BE LIMITED TO AN ACTION FOR MANDAMUS OR SPECIFIC PERFORMANCE.

(iv) No default by the Issuer in observing or performing its obligations under this Section shall comprise a breach of or default under this Resolution for purposes of any other provision of this Resolution. Nothing in this Section is intended or shall act to disclaim, waive, or otherwise limit the duties of the Issuer under federal and state securities laws.

(v) The provisions of this Section may be amended by the Issuer from time to time to adapt to changed circumstances that arise from a change in legal requirements, a change in law, or a change in the identity, nature, status, or type of operations of the Issuer, but only if (1) the provisions of this Section, as so amended, would have permitted an underwriter to purchase or sell Series 2014 Bonds in the primary offering of the Series 2014 Bonds in compliance with the Rule, taking into account any amendments or interpretations of the Rule since such offering as well as such changed circumstances and (2) either (a) the holders of a majority in aggregate principal amount (or any greater amount required by any other provision of this Resolution that authorizes such an amendment) of the Outstanding Series 2014 Bonds consent to such amendment or (b) a person that

is unaffiliated with the Issuer (such as bond counsel) determines that such amendment will not materially impair the interest of the holders and beneficial owners of the Series 2014 Bonds. If the Issuer so amends the provisions of this Section, it shall include with any amended financial information or operating data next provided in accordance with subsection (a) of this Section an explanation, in narrative form, of the reason for the amendment and of the impact of any change in the type of financial information or operating data so provided. The Issuer may also amend or repeal the provisions of this continuing disclosure agreement if the SEC amends or repeals the applicable provision of the Rule or a court of final jurisdiction enters judgment that such provisions of the Rule are invalid, but only if and to the extent that the provisions of this sentence would not prevent an underwriter from lawfully purchasing or selling Series 2014 Bonds in the primary offering of the Series 2014 Bonds.

Section 31. SALE OF SERIES 2014 BONDS. Pursuant to the authorizations in Section 3 hereof, as approved by the Authorized Officer, the Series 2014 Bonds may be sold either pursuant to the taking of bids therefor as provided in an Official Notice of Sale or pursuant to a purchase agreement (the "Purchase Agreement") with a purchaser or purchasers (collectively, the "Underwriters") to be approved by the Authorized Officer, and any supplements thereto which may be necessary to accomplish the issuance of Bonds. Such Purchase Agreement is hereby authorized to be dated, executed and delivered on behalf of the Issuer by an Authorized Officer, with such changes therein as shall be approved by the Authorized Officer, the execution thereof by the Authorized Officer to constitute evidence of such approval. The delegation of authority to the Authorized Officer to approve the final terms of the Bonds as set forth in this Resolution is, and the decisions made by the Authorized Officer pursuant to such delegated authority will be, in the best interests of the Issuer, and the Authorized Officer is authorized to make a finding to such effect in the Approval Certificate.

Section 32. APPROVAL OF OFFICIAL STATEMENT. A Preliminary Official Statement relating to the Series 2014 Bonds, in substantially the form as submitted to the Board of Directors at this meeting, is hereby approved and authorized to be distributed to prospective investors and other interested parties in connection with the underwriting and sale of the Series 2014 Bonds, with such changes therein as shall be approved by the President of the Board of Directors or the General Manager of the Issuer, including such changes as are necessary for distribution as a final Official Statement. It is further officially found, determined, and declared that the statements and representations contained in said Preliminary Official Statement are true and correct in all material respects. The use and distribution by the Purchaser of the Official Statement relating to the Series 2014 Bonds, is hereby approved. For the purpose of review by the Purchaser prior to purchasing the Series 2014 Bonds, the Issuer deems said Preliminary Official Statement to have been "final as of its date" within the meaning of Securities and Exchange Commission Rule 15c2-12.

Section 33. ATTORNEY GENERAL FEES. The Issuer hereby authorizes and directs payment, from legally available funds of the Issuer, of the nonrefundable examination fee of the Attorney General of the State of Texas required by Section 1202.004, Texas Govemment Code, as amended.

Section 34. FURTHER PROCEDURES. The President and the Secretary of the Board of Directors and the General Manager and the Finance Director of the Issuer, and all other officers,

employees, and agents of the Issuer, and each of them, shall be and they are hereby expressly authorized, empowered, and directed from time to time and at any time to do and perform all such acts and things and to execute, acknowledge, and deliver in the name and on behalf of the Issuer all such instruments, whether or not herein mentioned, as may be necessary or desirable in order to carry out the terms and provisions of this Resolution, and all details in connection therewith. In case any officer whose signature shall appear on any Series 2014 Bond shall cease to be such officer before the delivery of such Series 2014 Bond, such signature shall nevertheless be valid and sufficient for all purposes the same as if such officer had remained in office until such delivery.

Section 35. REPEAL OF CONFLICTING RESOLUTIONS. All resolutions and all parts of any resolutions which are in conflict or inconsistent with this Resolution are hereby repealed and shall be of no further force or effect to the extent of such conflict or inconsistency.

Section 36. PUBLIC NOTICE. It is hereby officially found and determined that public notice of the time, place and purpose of said meeting was given, all as required by the Government Code, Chapter 551.

EXHIBIT "A"

WRITTEN PROCEDURES RELATING TO CONTINUING
COMPLIANCE WITH FEDERAL TAX COVENANTS

A. Arbitrage. With respect to the investment and expenditure of the proceeds of the Series 2014 Bonds and any Additional Bonds (the "Obligations") the Issuer's General Manager, Assistant General Manager, and Director of Finance (the "Responsible Persons") will :

For Obligations issued for newly acquired property or constructed property:

- instruct the appropriate person or persons that the construction, renovation or acquisition of the facilities must proceed with due diligence and that binding contracts for the expenditure of at least 5%of the proceeds of the Obligations will be entered into within 6 months of the Issue Date;

- monitor that at least 85% of the proceeds of the Obligations to be used for the construction, renovation or acquisition of any facilities are expended within 3 years of the date of delivery of the Obligations ("Issue Date");

- restrict the yield of the investments (other than those in the Reserve Fund) to the yield on the Obligations after 3 years of the Issue Date;

- monitor all amounts deposited into a sinking fund or funds, e.g., the Interest and Redemption Fund and the Reserve Fund, to assure that the maximum amount invested at a yield higher than the yield on the Obligations does not exceed an amount equal to the debt service on the Obligations in the succeeding 12 month period plus a carryover amount equal to one-twelfth of the principal and interest payable on the Obligations for the immediately preceding 12-month period;

- assure that no more than 50% of the proceeds of the Obligations are invested in an investment with a guaranteed yield for 4 years or more;

- assure that the maximum amount of the Reserve Fund invested at a yield higher than the yield on the Obligations will not exceed the lesser of (1) 10% of the original principal amount of the Obligations, (2) 125% of the average annual debt service on the Obligations measured as of the Issue Date, or (3) 100% of the maximum annual debt service on the Obligations as of the Issue Date;

For Obligations issued for refunding purposes:

- monitor the actions of the escrow agent (to the extent an escrow is funded with proceeds) to assure compliance with the applicable provisions of the escrow agreement, including with respect to reinvestment of cash balances;

For all Obligations:

- maintain any official action of the Issuer (such as a reimbursement resolution) stating its intent to reimburse itself or the City with the proceeds of the Obligations any amount expended prior to the Issue Date for the acquisition, renovation or construction of the facilities;

- assure that the applicable information return (e.g., IRS Form 8038-G, 8038-GC, or any successor forms) is timely filed with the IRS;

- assure that, unless excepted from rebate and yield restriction under section 148(f) of the Code, excess investment earnings are computed and paid to the U.S. government at such time and in such manner as directed by the IRS (i) at least every 5 years after the Issue Date and (ii) within 30 days after the date the Obligations are retired.

B. Private Business Use. With respect to the use of the facilities financed or refinanced with the proceeds of the Obligations the Responsible Persons will:

- monitor the date on which the facilities are substantially complete and available to be used for the purpose intended;

- monitor whether, at any time the Obligations are outstanding, any person, other than the Issuer or the City, the employees of the Issuer or the City, the agents of the Issuer or the City or members of the general public has any contractual right (such as a lease, purchase, management or other service agreement) with respect to any portion of the facilities;

- monitor whether, at any time the Obligations are outstanding, any person, other than the Issuer or the City, the employees of the Issuer or the City, the agents of the Issuer or the City or members of the general public has a right to use the output of the facilities (e.g., water, gas, electricity);

- monitor whether, at any time the Obligations are outstanding, any person, other than the Issuer or the City, the employees of the Issuer or the City, the agents of the Issuer or the City or members of the general public has a right to use the facilities to conduct or to direct the conduct of research;

- determine whether, at any time the Obligations are outstanding, any person, other than the Issuer or the City, has a naming right for the facilities or any other contractual right granting an intangible benefit;

- determine whether, at any time the Obligations are outstanding, the facilities are sold or otherwise disposed of; and

- take such action as is necessary to remediate any failure to maintain compliance with the covenants contained in the resolution authorizing the Obligations.

C. Record Retention. The Responsible Persons will maintain or cause to be maintained all records relating to the investment and expenditure of the proceeds of the Obligations and the use of the facilities financed or refinanced thereby for a period ending three (3) years after the complete extinguishment of the Obligations. If any portion of the

Obligations is refunded with the proceeds of another series of tax-exempt obligations, such records shall be maintained until the three (3) years after the refunding obligations are completely extinguished. Such records can be maintained in paper or electronic format.

D. Responsible Persons. Each Responsible Person shall receive appropriate training regarding the Issuer's accounting system, contract intake system, facilities management and other systems necessary to track the investment and expenditure of the proceeds and the use of the facilities financed with the proceeds of the Obligations. The foregoing notwithstanding, the Responsible Persons are authorized and instructed to retain such experienced advisors and agents as may be necessary to carry out the purposes of these instructions.

EXHIBIT "B"

DESCRIPTION OF ANNUAL FINANCIAL INFORMATION

The following information is referred to in Section 30 of this Resolution.

I. Annual Financial Statements and Operating Data of the Issuer

The financial information and operating data with respect to the Issuer to be provided annually in accordance with such Section are as specified (and included in the Appendix or under the headings of the Official Statement and Tables referred to) below:

Tables 1 through 9 in the Official Statement and in Appendix B

Accounting Principles

The accounting principles referred to in such Section are the accounting principles described in the notes to the financial statements referred to in paragraph 1 above.

THIS DOCUMENT WAS ORIGINALLY APPROVED BY THE TRWD BOARD OF DIRECTORS ON MAY 20, 2014.

TARRANT REGIONAL WATER DISTRICT

WATER CONSERVATION AND DROUGHT CONTINGENCY PLAN

MAY 2014

David Marshall, P.E.

Linda Christie, J.D.

Tarrant Regional Water District
800 East Northside Drive
Fort Worth, TX 76102
817/335-2491

ACKNOWLEDGEMENTS

Tarrant Regional Water District (TRWD) has modified this plan to maintain a consistent and regional approach to water conservation and drought response strategies. Certain sections of the plan were customized to meet the needs of TRWD customers. The plan was prepared pursuant to Texas Commission on Environmental Quality rules. Some material is based on the existing water conservation plans listed in Appendix A. Conservation and emergency water management (drought contingency) plans for the City of Fort Worth and the City of Dallas were used extensively.

Questions regarding this water conservation and drought contingency plan should be addressed to the following:

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TARRANT REGIONALWATER DISTRICT

Water Conservation and Drought Contingency Plan

MAY 2014

1. INTRODUCTION AND OBJECTIVES

The water supplies we depend on are not endless resources. For one thing, drought conditions are a part of life here in North Texas. Droughts are unpredictable but they have a direct impact on our water resources. Without rainfall and runoff the reservoirs we rely on to meet our needs are depleted faster than they are replenished. In addition, the number of people living in our region is expected to double in the next 50 years. That means the demand for water will certainly rise – and meeting that demand will be a challenge.

In recent years, the growing population and economic development in North Texas has led to an increase in demands for water supplies. At the same time, local and less expensive sources of water supply are largely developed. In planning and developing new water supplies, water conservation strategies will play a vital role in meeting TRWD's projected water needs. The 2012 State Water Plan reports that 12 percent of future water needs in Region C will be met through municipal conservation.[1] From a cost standpoint, water conservation is the most cost-effective alternative for meeting new water demands. Therefore it is important that we use the water we already have more efficiently.

Over time, conserving water on a daily basis:

- extends the life of existing supplies to meet new water demands
- slows the drain on reservoirs making more water available during times of drought
- reduces peak supply requirements, which reduces wear and tear on existing infrastructure
- defers increases in capital and operating costs for existing systems, and
- delays the need for developing expensive, new water supplies.

Recognizing the need for efficient use of existing water supplies, the Texas Commission on Environmental Quality (TCEQ) has issued guidelines and requirements governing the development of water conservation and drought contingency plans for wholesale water suppliers.[1, 2] TCEQ guidelines and requirements for wholesale suppliers are included in Appendix B. The best management practices published by the Water Conservation Implementation Task Force[3], and established pursuant to SB1094 by the 78th Legislature, were also considered in the development of water conservation measures.

TRWD is a regional wholesale public water supplier serving four primary customers including the cities of Arlington, Fort Worth, Mansfield and the Trinity River Authority and numerous other customers across eleven counties. The service area includes Jack, Wise, Denton, Parker, Tarrant, Johnson, Ellis, Kaufman, Henderson, Navarro and Freestone counties. The Water District currently provides water to more than 1.8 million people. This plan replaces the plan dated April 2009.

The water conservation sections of this plan include measures that are intended to result in ongoing, long-term water savings. The TRWD drought contingency and water emergency response sections of this plan address strategies designed to temporarily reduce water use in response to specific conditions.

The objectives of this water management plan are as follows:

- To reduce water consumption from the levels that would prevail without conservation efforts.
- To reduce the loss and waste of water.
- To improve efficiency in the use of water.
- To document the level of recycling and reuse in the water supply.
- To extend the life of current water supplies by reducing the rate of growth in demand.

This plan includes all the elements required by TCEQ. Some elements go beyond TCEQ requirements. Customers of TRWD wishing to adjust elements of their individual plan should coordinate with TRWD. The final adopted versions of customer water conservation and drought contingency plans including appendices, rules, resolutions and ordinances should be provided to TRWD, as well as TCEQ and the Texas Water Development Board (TWDB).

There are additional water saving measures not specifically mentioned in the plan. TRWD urges all water users to implement the highest level of water saving measures that are feasible. It also encourages all commercial and industrial entities to further their conservation and reuse efforts to the maximum extent practicable.

2. TEXAS COMMISSION ON ENVIRONMENTAL QUALITY RULES

2.1 Conservation Plans

The TCEQ rules governing development of water conservation plans for wholesale water suppliers are contained in Title 30, Part 1, Chapter 288, Subchapter A, Rule 288.5 of the Texas Administrative Code, which is included in Appendix B. For the purpose of these rules, a water conservation plan is defined as "A strategy or combination of strategies for reducing the volume of water withdrawn from a water supply source, for reducing the loss or waste of water, for maintaining or improving the efficiency in the use of water, for increasing the recycling and reuse of water, and for preventing the pollution of water. A water conservation plan may be a separate document identified as such or may be contained within another water management document(s)." [1] The elements in the TCEQ water conservation rules covered in this conservation plan are listed below.

Minimum Conservation Plan Requirements for Wholesale Water Suppliers

TRWD is a wholesale water supplier to cities and other customers in North Central Texas. In addition to municipalities, TRWD serves utility districts, water supply corporations, and smaller entities, such as schools and golf courses. The minimum requirements in the Texas Administrative Code for water conservation plans for wholesale water suppliers are covered in this report as follows:

- 288.5(1)(A) – Description of Service Area – Section 3 and Appendix C
- 288.5(1)(B) – Specific, Quantified Five and Ten year Goals – Section 4
- 288.5(1)(C) – Measure and Account Water Diverted – Section 5.1
- 288.5(1)(D) – Monitoring and Record Management System – Sections 5.2 and 7.4
- 288.5(1)(E) – Program of Metering and Leak Detection and Repair – Section 5.3
- 288.5(1)(F) – Requirement for Water Conservation Plans by Wholesale Customers – Section 6.1
- 288.5(1)(G) – Reservoir System Operation Plan – Section 6.2
- 288.5(1)(H) – Means of Implementation and Enforcement – Section 9
- 288.5(1)(I) – Documentation of Coordination with Regional Water Planning Groups – Section 6.3
- 288.5(3) – Review and Update of Plan – Section 10

Additional Conservation Strategies

The Texas Administrative Code lists additional water conservation strategies that can be adopted by a wholesale supplier but are not required. Additional strategies adopted by Tarrant Regional Water District include the following:

- 288.5(2)(B) – Program to Assist Customers – Section 7

- 288.5(2)(C) – Program for Reuse and/or Recycling – Section 8.1
- 288.5(2)(D) – Other measures – Sections 8.2 (public education) and 8.3 (in-house conservation measures)

2.2 Drought Contingency Plans

The TCEQ rules governing development of drought contingency plans for wholesale water suppliers are contained in Title 30, Part 1, Chapter 288, Subchapter B, Rule 288.22 of the Texas Administrative Code, which is included in Appendix B.

For the purpose of these rules, a drought contingency plan is defined as "a strategy or combination of strategies for temporary supply and demand management responses to temporary and potentially recurring water supply shortages and other water supply emergencies. A drought contingency plan may be a separate document identified as such or may be contained within another water management document(s)." [2] The drought contingency plan for TRWD is contained in Section 11 of this water management plan.

3. DESCRIPTION OF TRWD SERVICE AREA

The Tarrant Regional Water District (TRWD) was established in 1924 as a political subdivision of the State of Texas. It has two primary missions: to provide our region with water and flood control.

The Water District is a regional wholesale water supplier located in North Central Texas. It provides untreated surface water to four primary customers in Tarrant County. They include the cities of Arlington, Fort Worth and Mansfield, and the Trinity River Authority (TRA). TRWD also provides water to some smaller utilities and other water user groups located near its reservoirs.

In addition to providing their own citizens with clean drinking water, Fort Worth, Mansfield and TRA supply neighboring municipalities and/or utility districts with treated water and wastewater services. Tables 3.1 through 3.3 list TRWD's customers (direct and indirect). An indirect customer refers to any successive wholesale customers of TRWD's primary customers.

The Water District has a total service population of approximately 1.8 million. It is ultimately responsible for serving 68 cities across an 11-county area. However, several of those cities are not currently taking water. Figure 3.1 shows the TRWD service area and supply system, which covers 5,891 square miles in Jack, Wise, Denton, Parker, Tarrant, Johnson, Ellis, Kaufman, Henderson, Navarro and Freestone counties. All but one of these counties is located within the Region C Water Planning Group – one of 16 water planning groups established by the Texas Water Development Board (TWDB) to develop and revise comprehensive water plans for the state. Johnson County is part of the Region G Water Planning Group.

TRWD uses a system of reservoirs to meet the water needs of its customers. Most of its raw water supplies originate from reservoirs constructed and managed by the Water District. They include Lake Bridgeport, Eagle Mountain Lake, Cedar Creek and Richland-Chambers Reservoirs. Two smaller reservoirs in Tarrant County – Lakes Benbrook and Arlington – are used for terminal storage. The total permitted supply currently available to TRWD is 773,100 acre-feet. However, the firm yield of the reservoir system is lower and stands at 533,833 acre-feet. These totals include 63,000 acre-feet from an indirect reuse project at Richland-Chambers Reservoir. The George W. Shannon Wetlands Water Recycling Facility began operation in October 2013. A future reuse project at Cedar Creek Reservoir will add 52,500 acre-feet to the system's supply. Additional information on TRWD's reuse and recycling efforts can be found in Section 8.1.

The Water District uses pump stations and approximately 184 miles of pipelines to transport water into Tarrant County from Cedar Creek and Richland-Chambers reservoirs in East Texas. Total pumping capacity from the eastern division reservoirs is 377 million gallons per day (MGD). The water from Lake Bridgeport and Eagle Mountain Lake on the West Fork of the Trinity River is gravity fed into Lake Worth.

Further details of TRWD's reservoir operations can be found in Section 6.2. Appendix C to the water conservation and drought contingency plans contains a profile for wholesale public water suppliers for TRWD, based on the format recommended by the TCEQ. Table 3.4 summarizes key facts from the wholesale supplier profile.

Table 3.1

TRWD Customers served by Eastern Division Reservoirs including Lake Benbrook, Cedar Creek Reservoir, and Richland-Chambers Reservoir

Lake Benbrook
Benbrook Water Authority
City of Weatherford
Fort Worth Country Day School (Irr.)
Mira Vista Golf Club (Irr.)
Ridglea Country Club (Irr.)
Whitestone Golf Club (Irr.)
Indirect Customers:
City of Hudson Oaks
Parker County Special Utility District
Parker County Utility District

Cedar Creek Reservoir
Bill Sisul/Shady Oaks Golf (Irr.)
Cedar Creek Country Club (Irr.)
City of Kemp
City of Mabank
City of Malakoff
City of Midlothian
City of Star Harbor
City of Trinidad
East Cedar Creek Freshwater Supply District
Exelon (Ind.)
Golf Driving Range
Long Cove Ranch (Irr.)
Monarch Utilities
Pinnacle Country Club (Irr.)
Post Oak Ranch (Irr.)
Tristream East Tx (Ind.)
West Cedar Creek MUD
Indirect Customers:
City of Payne Springs

Cedar Creek Reservoir (continued)
City of Seven Points
City of Tool
Richland-Chambers Reservoir
Freestone (Ind.)
City of Corsicana
City of Fairfield
Winkler Water Supply

Table 3.2

TRWD Customers served by Western Division Reservoirs, including Lake Bridgeport and Eagle Mountain Lake

Lake Bridgeport
Brazos Electric Power Company (Ind.)
City of Bridgeport
City of Jacksboro
City of Runaway Bay
Hanson Aggregates (Ind.)
Martin Marietta (Ind.)
Runaway Bay Golf Club (Irr.)
Suez/Wise County Power (Ind.)
Walnut Creek Special Utility District
West Wise Rural Water Supply Corp.
Wise County Water Supply District (Decatur)
Indirect Customers:
City of Boyd
City of Decatur
City of Newark
City of Paradise
City of Reno
City of Rhome

Eagle Mountain Lake
City of Azle
City of River Oaks
City of Springtown
Community Water Supply
Hawk's Creek Golf Club (Irr.)
Shady Oaks Country Club (Irr.)
Trinity Materials (Ind.)
TXU Eagle Mountain Plant (Ind.)

Table 3.3

Wholesale Water Customers Served by TRWD's Primary Customers: the cities of Arlington, Fort Worth, Mansfield and the Trinity River Authority

Arlington:	
City of Grand Prairie	

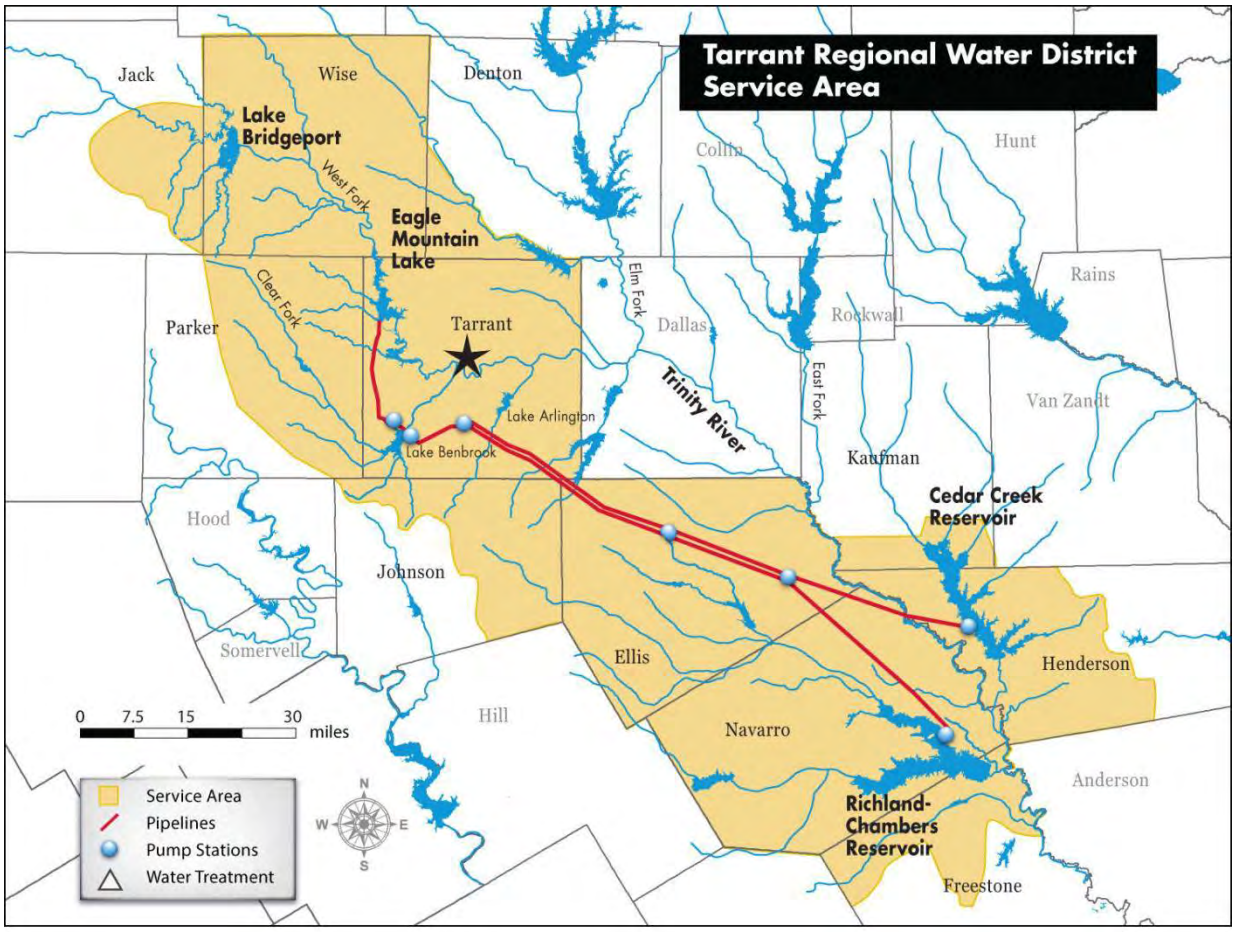
Fort Worth (List includes current and future customers)	
City of Aledo	City of Northlake
Bethesda Water Supply Corporation	City of North Richland Hills
City of Burleson	City of Richland Hills
City of Crowley	City of Roanoke
City of Dalworthington Gardens	City of Saginaw
City of Edgecliff Village	City of Sansom Park Village
City of Everman	City of Southlake
City of Forest Hill	City of Watauga
City of Grand Prairie	City of Westlake
City of Haltom City	City of Westover Hills
City of Haslet	City of Westworth Village
City of Hurst	City of White Settlement
City of Keller	Dallas-Fort Worth International Airport
City of Kennedale	Trinity River Authority
City of Lake Worth	Trophy Club Municipal Utility District

Mansfield	
City of Grand Prairie	
Johnson County Special Utility District	

Trinity River Authority	
<u>Cities served through Tarrant County Water Supply Project:</u> City of Bedford City of Colleyville City of Euless City of Grapevine City of North Richland Hills <u>Cities served by direct contract:</u> City of Ennis City of Midlothian <u>Cities and entities served under the Ellis County contract:</u> Avalon Water and Sewer Service Corporation	Buena Vista-Bethel Special Utility District City of Ferris City of Italy City of Maypearl City of Midlothian City of Palmer City of Red Oak Ellis County Water Control and Improvement District (City of Waxahachie) Nash-Forreston Water Supply Corporation Rockett Special Utility District <u>Indirect Customers:</u> City of Venus

Figure 3-1

Tarrant Regional Water District Service Area and Supply System Map



Summary of Wholesale Public Water Supplier Profile for Tarrant Regional Water District

Water District Service Area:	5,891 square miles
Water Supply Sources (Year Impounded):	Lake Bridgeport (1931) Eagle Mountain Lake (1932) Lake Benbrook (1952) Cedar Creek Reservoir (1965) Richland-Chambers Reservoir (1987)
Distribution System:	Cedar Creek Pipeline: Year completed: 1971 Length: 75 miles Diameter: 72-inches Maximum capacity: 127 mgd Richland-Chambers Pipeline Year completed: 1989 Length: 78 miles Diameter: 90-inches Maximum capacity: 249 mgd Benbrook Pipeline: Year completed: 1998 Length: 11 miles Diameter: 90-inches Eagle Mountain Pipeline: Year completed: 2008 Length: 20 miles Diameter: 90 and 84-inches Eleven Pump Stations: Cedar Creek, Richland-Chambers, Ennis (2), Waxahachie (2), Lake Benbrook (2), Rolling Hills Drinking Water Treatment Plant, Richland-Chambers Wetlands Water Reuse Project (2)
Population (2009 plan): Estimated Population in 2008: Projected Population in 2050:	 1,733,983 3,322,927
Population (2014 plan): Estimated Population in 2013: Estimated Population in 2060::	 1,817,900 4,287,600

Total Water Diversions for all Water Uses (in acre-feet) 2000 – 2013:		
Year	Volume	Population Served
2000	393,910	1,440,342
2001	394,318	1,473,172
2002	356,140	1,505,912
2003	428,734	1,538,652
2004	355,866	1,587,452
2005	523,482	1,622,908
2006	473,527	1,659,137
2007	355,900	1,696,157
2008	441,114	1,733,983
2009	340,596	1,796,405
2010	352,854	1,771,443
2011	404,402	1,781,735
2012	369,243	1,795,707
2013	356,240	1,817,900

4. SPECIFICATION OF WATER CONSERVATION GOALS

TCEQ rules require the adoption of specific water conservation goals to be included in this water conservation plan. The goals must include five and ten year targets for water savings, including, where appropriate, target goals for municipal use in gallons per capita per day across the Water District service area. However, as a wholesale water supplier, TRWD does not directly control the water use of its customers nor does it have a direct relationship with the retail customers who are the ultimate consumers of the water.

Many of TRWD's municipal customers are projected to have increasing per capita demands in the future.[4] The reasons for these projected increases include the following:

- The transformation of portions of the TRWD service area from historically rural to primarily suburban areas.
- Rapid population growth, which has historically been associated with increasing per capita municipal water use in North Texas.
- The influx of commercial development, changes in housing types, and growth in employment associated with urbanization.

The municipal per capita use for TRWD's system can be affected by changes in per capita use of its customers. It can also be affected by how much water TRWD is asked to supply to high per capita use customers versus low per capita use customers. These factors and others, such as increases in industrial or commercial usage and municipal water losses, cannot be controlled by TRWD.

TRWD does control the operation of its water supply and delivery system and can take direct action to maximize the efficiency of that system. In areas under its direct control, TRWD adopts the following goals for water conservation and efficiency:

- Keep the level of unaccounted water in the system below 5%, as discussed in Section 5.2.
- Maintain universal metering of customers, meter calibration, and meter replacement and repair, as discussed in Section 5.2.
- Maintain a program of leak detection and repair, as discussed on Section 5.3.
- Begin to utilize indirect reuse as a major source of water supply, as discussed in Section 8.1.
- Continue to implement in-house water conservation efforts, as discussed in Section 8.4.
- Raise public awareness of water conservation and encourage responsible public behavior by a public education program, as discussed in Section 8.2.

As a wholesale provider, TRWD will assist its customers in the development of water conservation programs. TRWD has developed a *Model Water Conservation Plan for*

TRWD Customers and a *Model Drought Contingency Plan for TRWD Customers* that its customers can use to develop their own water conservation and drought contingency plans.

As part of the model water conservation plan, TRWD requires water utility customers to provide annual water conservation reports, modeled after the Utility Profile developed by TCEQ. A copy of the report is included in Appendix F. TRWD will review these reports and compile the information as part of its own annual conservation report, which will be used to manage TRWD's water conservation program.

In calculating target goals for per capita water savings among its municipal users, TRWD focused on water use among its four primary customers in Tarrant County. The cities of Arlington, Fort Worth, Mansfield and the Trinity River Authority and their successive customers (listed in Table 3.2) receive an average of 90 to 92 percent of all TRWD water deliveries. Table 4.1 summarizes annual water use for these customers from 2003 – 2013. The data shown in the table reflect the following:

- Population estimates (Table 4.2) are based on information provided by the North Central Texas Council of Governments (NCTCOG). The art of estimating population is by no means an exact science. The NCTCOG methodology for determining population is based on building permits, occupancy factors and household size factors. The figures are reviewed at a regional level for consistency with other indicators of regional population such as labor force estimates and vital statistics.[5]
- Populations of some TRA customers were adjusted to reflect the percentage of water needs it meets within those cities, (Grapevine: 52 percent; North Richland Hills: 37 percent). Populations were also adjusted for communities that rely on groundwater to supplement water supplies, (Bedford: 85 percent; Colleyville: 93 percent; Euless: 76 percent).
- The Water District serves approximately 98 percent of Tarrant County. Its four primary customers and the customers they serve represent approximately 92 percent of the total Tarrant County population.
- The gallons per capita per day (gpcd) figures represent all water uses among our primary customers and are calculated by dividing total amount of water diverted and/or pumped for potable use by total population.[6] Water use categories include residential, commercial, institutional, and industrial, as well as process-related and municipal system water losses.
- Industrial use varies by community and represents approximately three percent of Arlington's water use, three percent of Mansfield's water use, and nine percent of Fort Worth's water use.
- Rainfall data recorded at DFW International Airport is also included to show the correlation between water use and precipitation. Higher water use is usually observed during periods of below average rainfall. This is predominantly due to an increase in the amount of water used for irrigation.

Table 4.1

Water Use among TRWD's Primary Customers and their Successive Customers 2003-2013, including Rainfall, Total Water Supplied, Estimated Population, and Total Municipal Gallons per Capita per Day

Year	Rainfall at DFW Airport (inches)	Total Water Supplied to Primary Customers	Estimated Population of Primary customers (including wholesale)	Total Municipal Gallons per Capita per Day
2003	24.55	301,061	1,445,291	185.4
2004	47.57	282,700	1,484,637	169.6
2005	18.97	344,596	1,523,983	201.2
2006	29.75	362,091	1,563,329	206.2
2007	50.05	284,343	1,597,425	158.5
2008	27.10	337,192	1,630,603	184.4
2009	40.89	306,686	1,663,338	164.6
2010	31.70	321,087	1,640,225	174.8
2011	25.88	364,846	1,649,755	197.4
2012	31.26	333,289	1,662,692	179.0
2013	29.40	308,400	1,683,241	163.6
Current 5-Year Average Per Capita Municipal Use among TRWD's Primary Customers without Credit for Reuse.				175.9

Total municipal gpcd = [(total acre-feet supplied x 325,851 gallons/acre-foot) / population] / 365 days per year]

Average gpcd with reuse taken into account for 2013 was 157.8.

Table 4.2

Estimated Population Served by TRWD's Primary Customers and their Successive Customers 2003-2013 based on data from the North Central Texas Council of Governments

Year	Arlington	Fort Worth	Mansfield	Trinity River Authority
2003	348,260	898,946	38,391	159,695
2004	353,356	927,430	41,844	162,007
2005	358,453	955,913	45,297	164,320
2006	363,550	984,397	48,750	166,632
2007	364,300	1,012,880	51,300	168,945
2008	369,150	1,034,958	54,618	171,877
2009	370,450	1,062,306	57,601	172,981
2010	365,438	1,042,160	56,368	176,260
2011	365,530	1,050,935	56,840	176,449
2012	365,860	1,062,299	57,490	177,043
2013	369,320	1,077,020	58,490	178,410
Percent increase 2004-2008	4.47%	11.59%	30.53%	6.09%
Percent increase 2009-2013	-0.31%	1.39%	1.54%	3.14%

In a special report to the 79th Legislature, the TWDB recommends a minimum annual reduction of one percent total gpcd, based upon a five-year rolling average until at such time as the entity achieves a total gpcd of 140 or less.[7] Table 4.3 shows projected municipal per capita water use for TRWD. The per capita use does not include the effect of new water conservation measures that may be adopted by TRWD customers. Table 4.3 also includes TRWD's targets for reduction to municipal per capita use due to the implementation of this water conservation and drought contingency plan and the plans to be developed by its customers. The information shown on the table reflects the following:

- The target for the five-year (2018) municipal per capita water use for TRWD's primary customers and their successive customers is 166 gallons per capita per day in an average climatic year, as shown in Table 4.3. This represents a five percent reduction of almost nine gallons per capita per day.
- The target for the ten-year (2023) municipal per capita water use for TRWD's primary customers and their successive customers is 158 gallons per capita per

day in an average climatic year, as shown in Table 4.3. This represents a decrease of 17 gallons per capita per day, or approximately ten percent.

- Projected total per capita water use figures are based on an average climate conditions. Per capita water use in years with less precipitation, especially during the summer, may be more than projected here.
- Indirect reuse diversion volumes shall be credited against total diversion volumes for the purpose of calculating gpcd for targets and goals.[7] The Water District estimates that over the next five years approximately 10 percent of its water supplies will be derived from indirect reuse. Credit for reuse is included in the five and ten year per capita goals.

Table 4.3

Five-Year and Ten-Year Municipal Per Capita Water Use Goals for TRWD's Primary Customers and their Successive Customers (Total GPCD)

Description	Year	Target Per capita	Per capita with Reuse
Current 5-Year Average Per Capita Municipal Use Among TRWD's Primary Customers	2004 – 2008	184	
5-Year Goal (5% reduction with credit for reuse)	2013	175	174.7
New 5-Year Goal (5% reduction with credit for reuse)	2018	166	
10-Year Goal (5% reduction with credit for reuse)	2023	158	

Additional verification of annual water savings can be found in an annual demand model of TRWD water use developed for the Strategic Water Conservation Plan. The model was calibrated using water demands among the district's primary customers from 1997 to 2004, before water conservation measures were put in place. The model is used to predict TRWD annual demands without conservation and allows for a comparison with actual demands. The difference between the model's projected demands and actual consumption is assumed to be savings.

Here are some highlights of the savings achieved from ongoing conservation efforts from 2007 through 2013:

- A cumulative savings of 104.7 billion gallons or 321,400 acre-feet.
- Annual savings ranging from 8.0 to 32.4 billion gallons, with savings on an annual basis averaging 15.0 billion gallons.

- An average savings of approximately 41.0 mgd. At the 2013 rolling average consumption rate (175.9 gpcd without reuse), 33.0 mgd could supply an additional 233,000 people annually.
- An average savings of almost 46,000 acre-feet per year.

The estimated savings among the district's primary customers in 2013 alone was nearly 100,000 acre-feet – which represents the average amount of water the District supplies from its Western Division reservoirs each year.. A chart illustrating the projected water demands versus actual demands and a table of the estimated annual savings is included below.

Figure 4-1

Estimated Consumption without Conservation vs. Actual Consumption

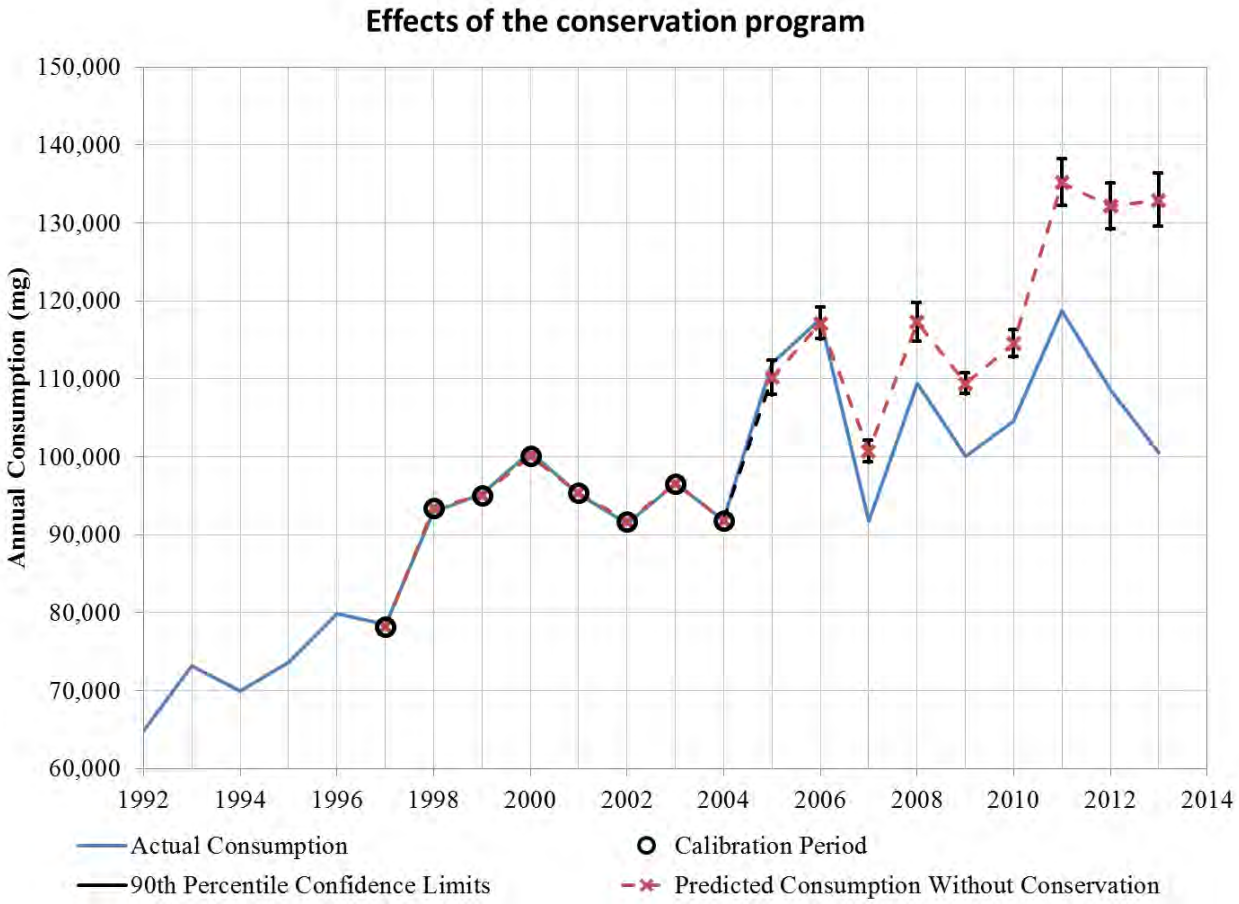


Table 4.4

Estimated Annual Savings Due to Ongoing Water Conservation Efforts and Drought Contingency Measures, 2007-2013

Year	Billion Gallons	Acre-Feet
2007	8.97	27,534
2008	7.95	24,395
2009	9.44	28,979
2010	9.65	29,612
2011	14.43	44,269
2012	21.86	67,070
2013	32.43	99,541
Total Savings	**104.72**	**321,400**

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5. METERING, WATER USE RECORDS, CONTROL OF UNACCOUNTED WATER, AND LEAK DETECTION AND REPAIR

One of the key elements in water conservation is careful tracking of water use and control of losses. Accurate metering of water deliveries and detection and repair of leaks in the raw water delivery system are important elements of TRWD's program to control losses.

5.1 Practices to Measure and Account for the Amount of Water Diverted

TRWD uses two different methods to measure raw water diversions from its reservoirs. Releases from Lake Bridgeport and Eagle Mountain Lake are determined using 48-inch diameter gate valves. Each valve is calibrated so that the volumetric flow rate can be calculated based the size of the gate opening. The Water District meters its raw water diversions from Cedar Creek and Richland-Chambers Reservoirs by meters with accuracy ±5%. The master meters are calibrated semi-annually and repaired or replaced as needed.

5.2 Monitoring and Record Management Program for Determining Deliveries, Sales, and Losses

As a wholesale water supplier, TRWD has instituted a monitoring and record management program to assure that its customers are charged appropriately for their water use. The program includes the following elements:

- Customers with annual demands less than 7,500 acre-feet are required to document their usage in a monthly raw water report. The report includes initiation dates, usage dates, customer name changes and meter status changes.
- TRWD performs scheduled and random readings of customer meters; with no less than three readings taken during a three-month period and a fourth quarter reading taken between September 20 and October 10. In addition, one random reading is performed annually between June 1st and September 30th.
- All meters are documented and the serial number is verified and recorded at each reading.
- Customers with a demand of 7,500 acre-feet or more must provide TRWD with a daily usage total and a monthly reconciliation of usage. Usage volumes are monitored and recorded daily. They are also verified monthly and annually.
- Customers are required to provide, operate, maintain, and read meters. By contract meters must have an accuracy ±5%. TRWD can access the meters at all reasonable times and, upon written request, can have the meters calibrated once per month. In the event a meter is not functioning properly, the customer is required to install a new meter or repair it within 180 days.
- The Water District has the authority to replace or repair any meter.

- Methods to verify water deliveries include calibration tests, mathematical calculations, and estimations based on historical meter data under similar conditions.
- Inaccurate meters at Lake Benbrook and Arlington discharge outlets were replaced in 2008. An additional full insertion probe meter was installed at the Benbrook discharge facility in 2014 to more accurately meter flows.
- TRWD reconciles the water deliveries and reservoir diversions into daily mass balances. All of the Water District's reservoir levels and local precipitation are monitored from USGS recording stations. Measured pan evaporations performed by the USACE are also recorded daily and utilized in conjunction with the TWDB's evaporation coefficients. Using all of the above data, daily mass balances of each reservoir are performed to calculate natural inflows.

One of the goals of TRWD's water conservation program is to maintain unaccounted water below five percent in every year.

5.3 Metering and Leak Detection and Repair

TRWD metering program for raw water is described in Sections 5.1 and 5.2. The following information details the Water District's program to control, detect and repair leaks of its pipeline system:

- All TRWD water transmission pipelines are reinforced concrete cylinder pipe or steel cylinder pipe with an internal protective liner and an external protective coating. Because of the multiple layers of material, these pipelines have very long service lives and are not subject to frequent development of leaks.
- Most joints in TRWD pipelines are designed with bell and spigot joint construction including rubber gasket. Some joints are welded. For larger lines, each joint is also sealed with concrete.
- All TRWD water pipelines are constructed in legally defined and identified rights-of-way, properly registered with authorities in each county.
- TRWD personnel routinely inspect Water District pumping equipment, facilities, and pipelines for leaks or mechanical problems. Aerial surveillance combined with ground observation is used to regularly inspect pipeline routes for breaks and leaks. Repairs are undertaken as soon as practicable in order to minimize waste.
- TRWD conducts annual inspections of sections of the Cedar Creek and Richland-Chambers pipelines using an advanced technology to assess the condition of pipe segments. The method, which uses remote field eddy current transformer coupling technology (RFEC/TC), is a non-destructive way of detecting broken wires in pre-stressed concrete pipe. The analysis is cost-effective and highly accurate, which allows the Water District to target individual pipe segments for replacement. Pipeline repairs are conducted during the winter when demands are typically at their lowest.

- In the summer 2004, TRWD employed the Pressure Pipe Inspection Company's Sahara Leak Detection Technology to inspect a ten-mile section of the Richland-Chambers pipeline where a number of wet areas were observed. No leaks were found and shallow groundwater appears to have been the source of the water-logged soil.
- TRWD operates a program for right-of-way identification for construction projects adjacent to Water District facilities and pipelines in order to minimize leaks caused by pipeline damage during construction
- In 2010, TRWD began conducting annual water loss audits of its pipeline system using AWWA's Water Loss Control Committee's Free Water Audit Software v4.2. The program compares total pumped volumes to billed metered diversions. To date, the pipeline water delivery system has achieved a score of 100 of 100 in each of the audits conducted. The results indicate, TRWD losses do not exceed an accepted standard of meter error of five percent.

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6. OTHER REQUIRED MEASURES

6.1 Requirement for Water Conservation Plans by Wholesale Customers

Every contract for the wholesale sale of water by TRWD entered into, renewed, or extended does include a requirement that the wholesale customer and any wholesale customers of that wholesale customer develop and implement a water conservation plan meeting the requirements of Title 30, Part 1, Chapter 288, Subchapter A, Rule 288.2 of the Texas Administrative Code. This requirement will extend to each successive wholesale customer in the resale of water. TRWD will provide the model water conservation and drought contingency plans described in Section 7.2 to all wholesale customers to assist them in developing their own water conservation and drought contingency plans.

6.2 Reservoir System Operation

TRWD currently has a permitted water supply from the following sources:

Lake Bridgeport (local)	15,000 acre-feet per year
Lake Bridgeport (downstream releases)	78,000 acre-feet per year
Eagle Mountain Lake	159,600 acre-feet per year
Cedar Creek Reservoir	175,000 acre-feet per year
Richland-Chambers Reservoir	210,000 acre-feet per year
Lake Benbrook	72,500 acre-feet per year
Reuse – Richland-Chambers*	63,000 acre-feet per year
Reuse – Cedar Creek*	52,500 acre-feet per year

*The Cedar Creek indirect reuse project represents future water supplies. A schedule for developing a water recycling facility at Cedar Creek Reservoir has not yet been determined. The indirect reuse project at Richland-Chambers Reservoir has been expanded and became fully functional in Fall 2013.

Permitted water supply does not reflect the amount of water TRWD can safely deliver to its customers without adversely affecting the watersheds from which the supplies originate. The following list of sources depicts the firm yield capacities of TRWD's reservoir system. Firm yield of a reservoir is typically defined as the maximum yield that could be delivered without failure during the historical drought of record.

Western Division reservoirs (includes Lake Bridgeport and Eagle Mountain Lake)	79,000 acre-feet per year
Cedar Creek Reservoir	175,000 acre-feet per year
Richland-Chambers Reservoir	210,000 acre-feet per year
Lake Benbrook	6,833 acre-feet per year
Reuse – Richland-Chambers	63,000 acre-feet per year
TOTAL	**533,833 acre feet per year**

TRWD's water supply network includes seven major reservoirs – Lake Bridgeport, Eagle Mountain Lake, Lake Worth, Cedar Creek Reservoir, Richland-Chambers Reservoir, Lake Arlington and Lake Benbrook. The Water District's reservoir system operation plan for its various sources of supply seeks to maximize efficiency of water withdraws within the constraints of existing water rights. Other priorities include maintaining water quality and minimizing potential impacts on recreational users, fish, and wildlife. Each reservoir is operated on a policy of flood release above the conservation elevation. Due to the geographic locations of the reservoirs, TRWD's operations are essentially split into two divisions.

Lake Bridgeport, Eagle Mountain Lake and Lake Worth comprise the Western Division. Each reservoir is situated on the West Fork of the Trinity River. Lake Bridgeport is located in Wise and Jack counties; Eagle Mountain Lake sits downstream in northwest Tarrant County; and Lake Worth is further downstream in Tarrant County. In addition to water supply, each of these reservoirs is used to regulate floodwaters on the West Fork.

The Water District may divert 93,000 acre-feet per year from Lake Bridgeport, of which, 78,000 acre-feet per year may be released downstream into Eagle Mountain Lake. TRWD may divert a maximum of 159,600 acre-feet per year from Eagle Mountain, but that total also includes water released from Lake Bridgeport into Eagle Mountain Lake. The estimated firm yield of the Western Division reservoirs is 79,000 acre-feet per year.

Water is gravity fed from Lake Bridgeport to Eagle Mountain and from Eagle Mountain to Lake Worth to water treatment plants in the city of Fort Worth and neighboring cities and industries. The Water District's operation of the West Fork seeks to maintain Lake Worth's elevation to support the intake of Fort Worth's Holly Water Treatment Plant and the cooling operations at Lockheed Martin.

TRWD follows a series of operational rules to minimize spills and evaporation and regulate elevation in Lake Worth. The TRWD system operation plan calls for a shift in water deliveries to the Eastern Division reservoirs if the combined storage capacity in Lake Bridgeport and Eagle Mountain falls below 50 percent.

Construction of a new pipeline, carrying water from Cedar Creek and Richland-Chambers to Eagle Mountain Lake, was completed in May 2008. The 20.5-mile extension taps into an existing pipeline at Lake Benbrook and continues to Eagle Mountain Lake. Water from East Texas can now be delivered into Eagle Mountain Lake for terminal storage. The additional water will help meet the future water needs of a rapidly growing northwest Tarrant County and should reduce pressure on the West Fork during periods of peak demand (summer) and drought. It also supplies the expanded capacity of the city of Fort Worth's Eagle Mountain Water Treatment Plant.

Cedar Creek and Richland-Chambers reservoirs generate most of the water supply from the Eastern Division. Lakes Arlington and Benbrook are primarily operated as terminal storage reservoirs. Cedar Creek Reservoir is situated in Kaufman and Henderson counties; Richland-Chambers Reservoir is located in Navarro and Freestone counties; Lake Arlington is located on Village Creek in Tarrant County; and Lake Benbrook is a U.S. Army Corps of Engineers project in southwest Tarrant County.

The firm yield of Cedar Creek Reservoir is 175,000 acre-feet per year. A 70-mile pipeline is used to transport water from Cedar Creek into Tarrant County. An outlet on the Cedar Creek pipeline allows the Water District to deliver water into Village Creek which flows into Lake Arlington. Richland-Chambers has a firm yield of 210,000 acre-feet per year. The Water District constructed a 78-mile pipeline to carry water from Richland-Chambers into Tarrant County. Both East Texas pipelines terminate at the City of Fort Worth's Rolling Hills Water Treatment Plant. A pipeline extension from Rolling Hills to Lake Benbrook was completed in 1998.

TRWD manages deliveries from its East Texas reservoirs to meet customer needs and to supplement lake volumes in Eagle Mountain Lake, Lake Arlington, and Lake Benbrook during off-peak periods. The yields from the latter two lakes are less than 10,000 acre-feet per year so most of the supply is by pipeline delivery. Under normal operating conditions, the Water District diverts water in excess of demands into Lake Arlington and Lake Benbrook. The goal is to bring each of these lakes to at or near conservation elevation (694' msl and 550' msl, respectively) prior to June 1 to maximize terminal storage and meet peak demands during the summer. Using Lake Arlington and Lake Benbrook to provide summertime water deliveries to customers minimizes energy costs. Pumping from East Texas ceases if Lake Benbrook is above conservation. However, pumping will resume if demands exceed the pumping capabilities from Lake Benbrook.

The Water District has permits for two indirect reuse projects at Richland-Chambers and Cedar Creek Reservoirs. The projects involve diverting return flows in the Trinity River through constructed wetland systems to remove pollutants, such as nutrients and sediment. The water will then be routed to the reservoirs to supplement yields by as much as 30 percent. The wetland water reuse facility at Richland-Chambers began operations in spring 2009. Additional details about the water recycling projects can be found in Section 8.1.

6.3 Water Conservation Implementation Report

Appendix D includes the TCEQ required water conservation implementation report. The report is due to the TCEQ by May 1, 2014, and every five years after that date. This report tracks water demands over a five-year period and provides an overview of TRWD's water conservation programs. The report also calls for the five and ten year per capita water use goals from the previous water conservation plan. The reporting entity must answer whether or not these goals have been met and if not, why not. The amount of water savings is also reported.

6.4 Coordination with Regional Water Planning Groups

Appendix L includes a copy of letters sent to the Chairs of Region C and Region D water planning groups with this water conservation and drought contingency plan.

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7. ADDITIONAL TRWD WATER CONSERVATION MEASURES TO ASSIST CUSTOMERS

TRWD will implement a number of water conservation measures intended to help direct and indirect customers with their water conservation planning, including:

- Holding water conservation workshops for the staff of customers within its service area.
- Providing model water conservation and drought contingency plans for use by customers in developing their own plans.
- Requiring an annual report on water conservation efforts from customers and developing a district water conservation report.

These measures will allow TRWD to serve as a regional resource for water conservation efforts in its service area.

7.1 Water Conservation Workshops

The Water District will continue to coordinate water conservation workshops for staff of customers (direct and indirect) that receive water from TRWD. The workshops will cover TCEQ requirements for water conservation and drought contingency plans, current TRWD water conservation efforts, water supply updates, municipal water conservation programs and best management practices, and related topics. TRWD has made available the model water conservation and drought contingency plans described in Section 7.2 to cities and assist in the development of their plans.

In 2007, the Water District held the first water conservation symposium for its customer cities, which is now an annual event. The program is designed to show customers strategies they can use to save water, save money, and reduce demands. Speakers from across the nation are invited to share their experience and expertise. Discussions center on key elements of successful water conservation programs. The symposium's success attracted the attention of other water suppliers. And in 2008, the event was expanded and is now jointly coordinated by the region's three major water providers – TRWD, North Texas Municipal Water District, and Dallas Water Utilities.

In addition to the symposium, the Water District joined other North Texas water suppliers, and the Dallas and Fort Worth Chambers of Commerce to coordinate a Legislative Summit in October 2008 for state and local lawmakers. The event, which focused on water supply and conservation issues impacting North Texas, was repeated for water utility managers and their staff.

Additional water conservation workshops and educational programs targeting end water users continue to play a role in the Water District's community outreach program. Further information on TRWD's public education and water conservation programs is listed in Section 8.2.

7.2 TRWD *Model Water Conservation Plan for TRWD Customers* and *Model Drought Contingency Plan for TRWD Customers*

In order to assist its cities in the development of their own water conservation and drought contingency plans, TRWD will develop a *Model Water Conservation Plan for TRWD Customers* and a *Model Drought Contingency Plan for TRWD Customers*. The model water conservation plan addresses the TCEQ requirements for water conservation plans for municipal use by public water suppliers and includes several provisions that go beyond TCEQ requirements. TRWD will work with its customers to develop water conservation and drought contingency plans using the model plan as a guide.

The model water conservation plan includes the following elements addressing TCEQ requirements for water conservation plans for public water suppliers: [1]

- 288.2(a)(1)(A) – Utility Profile
- 288.2(a)(1)(B) – Record Management, Customer Classification
- 288.2(a)(1)(C) – Specification of Goals
- 288.2(a)(1)(D) – Accurate Metering
- 288.2(a)(1)(E) – Universal Metering
- 288.2(a)(1)(F) – Determination and Control of Unaccounted Water
- 288.2(a)(1)(G) – Public Education and Information Program
- 288.2(a)(1)(H) – Non-promotional Water Rate Structure
- 288.2(a)(1)(I) – Reservoir System Operation Plan
- 288.2(a)(1)(J) – Means of Implementation and Enforcement
- 288.2(a)(1)(K) – Coordination with Regional Water Planning Group
- 288.2(a)(2)(A) – Leak Detection, Repair, and Water Loss Accounting
- 288.2(a)(2)(B) – Record Management System
- 288.2(a)(2)(C) – Requirement for Water Conservation Plans by Wholesale Customers

TRWD's model water conservation plan also includes water conservation strategies that go beyond TCEQ's requirements:

- 288.2(a)(3)(A) – Conservation Oriented Water Rates
- 288.2(a)(3)(B) – Ordinances, Plumbing Codes or Rules on Water-Conserving Fixtures
- 288.2(a)(3)(D) – Reuse and Recycling of Wastewater
- 288.2(a)(3)(F) – Landscape Water Management Ordinance
- 288.2(a)(3)(G) – Monitoring Method

7.3 Annual Reports

One element of TRWD's *Model Water Conservation Plan for TRWD Customers* is a requirement that all water supply customers (direct and indirect) produce annual conservation reports (Appendix F) by May1 the following year and submit them to TRWD. TRWD will compile these reports and use them to help generate its own annual water conservation report. The Water District's report will be used to review the effectiveness of its water conservation program.

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8. ADDITIONAL TRWD WATER CONSERVATION MEASURES

8.1 Indirect Reuse and Recycling of Water

Indirect and/or direct reuse is a major part of future water supply plans for North Texas. TRWD is taking a lead role in water reuse by recycling return flows in the Trinity River. Return flows are a renewable resource; they are made up of water discharged by wastewater treatment plants in Fort Worth-Dallas area. A large portion of those flows originated from reservoirs managed by the Water District.

Here's how indirect reuse projects work:

A) Treated water from area lakes is consumed in homes and business.

B) Water that flows down the drain ends up at a wastewater treatment plant.

C) Wastewater treatment plants clean the water and release it into the Trinity River. However, discharges from wastewater treatment plants can contain elevated levels of nutrients, such as nitrogen and phosphorus.

D) As the water flows downstream, it picks up sediments, more nutrients, and other pollutants along the way.

E) The return flows are captured and pumped into constructed wetlands. The wetlands provide a natural way to remove sediments and nutrients from the river water.

F) With most of the sediments and nutrients removed, the naturally treated water is returned to area lakes to supplement drinking water supplies.

G) Water from lakes is pumped to drinking water treatment plants, then back into homes and businesses and reused.

The first of TRWD's two planned indirect reuse projects began supplementing water supplies in fall 2013. The George Shannon Wetlands Water Recycling Facility is a 2,000-acre constructed wetland system adjacent to Richland-Chambers Reservoir. The project is permitted to supply 63,000 acre-feet of treated river water to the reservoir annually, which averages out to more than 56 million gallons per day (MGD). Over the next five years, the Water District plans to recycle enough water from the Trinity River to make up more than 10 percent of its raw water supplies.

Another 2,000-acre facility is planned for Cedar Creek Reservoir, as water demands increase. When completed, the second wetland project will add 52,500 acre-feet to the reservoir. These unique projects will ultimately supplement current yields in each reservoir by 30 percent.

8.2 Public Education Program

TRWD will work closely with its customers (direct and indirect) to inform consumers on ways to use water more efficiently. TRWD's public education program is intended to

assist and supplement the public education efforts of its customers. TRWD's public education efforts include the following elements:

New conservation initiatives implemented by TRWD since 2009:

Public Education and Media Outreach Campaign

- TRWD continues to support the regional water conservation outreach campaign with Dallas Water Utilities. And media outreach is a huge factor in educating residents about water efficiency and ways to reduce water waste. The program has been successful. A recent survey of Tarrant County residents indicates that 62 percent of respondents have changed their behavior to be more efficient as a result of our outreach campaign, and 84 percent water twice per week or less, which has been the main message of our campaign in recent years.

Strategic Water Conservation Plan Implementation

- After a multi-year effort, Alan Plummer and Associates, Inc. finalized a Strategic Water Conservation Plan for the Water District in 2013. The executive summary from the plan is included in Appendix G.

  The plan evaluates customer water use, current water conservation programs, and proposes a lineup of new water saving strategies to build on our success. Understanding the driving forces behind our water use patterns, predicting how those conditions will impact water supplies, and developing a strategic roadmap to guide the implementation of future conservation policies will keep us focused on effective ways to support customer water conservation efforts.

  The Strategic Plan evaluated the cost and effectiveness of twenty water conservation measures. These particular strategies were screened and selected because of their water savings potential, customer feedback, and their applicability to the majority of customers in the water district's service area. The top six measures projected to generate the highest per capita savings included a combination of active and passive measures[i]:

  - Twice per week irrigation limits 6.20 gpcd
  - Water use reductions due to price increases 4.74 gpcd
  - Natural toilet replacement 1.07 gpcd
  - Clothes washer natural replacement 0.96 gpcd
  - Model water conservation ordinance 0.62 gpcd
  - Wholesale customer water loss reduction 0.42 gpcd

  By 2017, the Plan estimates the total per capita savings generated by these measures will be 14.01 gallons per day. These six measures represent 89.8 percent of all the water savings outlined in the Plan.

Putting the Strategic Water Conservation Plan into motion is high on our priority list. Representatives of our primary customers are helping to guide the lineup of strategies to pursue. Items on the list that are in progress include the development of a best management program for golf courses, a draft model landscape ordinance, and a water loss reduction program, consisting of workshops and the development and tracking of performance indicators. The Water District is also supporting a popular homeowner irrigation evaluation program (described below) on a small scale for its customers.

Twice-per-Week Watering Restrictions

- Outdoor water use, particularly lawn watering, can account for half or more of annual residential water use – and much more than that during the hot, dry Texas summers. And studies show that homeowners have a tendency to overwater, by as much as 2-3 times the amount needed by landscapes. Placing limits on outdoor irrigation is one way to reducing excessive water use outdoors and stretch existing supplies. A white paper containing additional details about the effectiveness of using twice-per-week outdoor irrigation schedules to conserve water is included in Appendix H.

  As the number one conservation strategy in its Strategic Plan, the Water District fully supports the efforts of its customer cities to adopt year-round twice-per-week watering restrictions. In fact, we recently worked with staff from Fort Worth Water Department to assist them in their effort to pass a mandatory twice per week watering ordinance (April 2014). A copy of the Fort Worth irrigation ordinance is included in Appendix I.

Irrigation Auditing Program

- The W.I.S.E. Guys program is a residential irrigation evaluation program that uses trained licensed irrigators to assess homeowner irrigation systems. Upon inspection they make recommendations for improving system performance, identify repair needs, and instruct users on how to schedule controllers to eliminate unnecessary outdoor watering.

  The evaluation includes an opportunity for a professional irrigator to educate homeowners about their systems, how to program them properly, and offer guidance on how much and how long to water throughout the year. Up to 500 irrigation evaluations will be provided through the program.

  In addition to the watering guidance, the pricing of this program includes the installation of a rain and freeze sensor for participants who do not have one already installed. Communities participating in the program this year include Arlington, Bedford, Hurst, Keller, Mansfield, North Richland Hills, and Fort Worth.

Airfield Falls Trailhead Water Conservation Garden

- In conjunction with the creation of a trail extension and a new trailhead on a tributary of the West Fork of the Trinity River, TRWD is building a destination

water conservation garden. The garden will be used to educate homeowners, developers, and landscapers about the benefits of water efficient landscaping. Phase 1 of the garden will be complete this spring. Phase 2 extending the garden further along the trail will begin in the fall.

The garden will feature an array of themes that homeowners can incorporate into their landscape. Topics of education will include planning and design, soil analysis and preparation, plant selection, practical turf and turf areas, efficient irrigation, mulching, and landscape best management practices.

ET Weather Station Support and Climate-based Weekly Watering Recommendations

- TRWD is installing two additional weather stations in Tarrant County to complement the one already operating at the National Weather Service. The TRWD stations will be integrated into the Texas ET Network and enable us to provide accurate weekly watering advice for Tarrant County residents on SaveTarrantWater.com. Development of the web site is in progress.

  The idea is to give residents the information they need to water appropriately and to reduce overwatering. We are currently sharing this information on the Lawn Whisperer and Save Tarrant Water Facebook pages. Last year, we received enough rainfall in Tarrant County to skip watering the lawn for a total of 33 weeks. It's important information that we also hope to share with media outlets, including radio, television, and newspapers.

Drought Outreach and Customer Assistance

- With drought potentially looming on the horizon in any given year, the water district offers regional support to customer cities. The support mainly consists of developing media messages for use on television, radio, web, and in print outlets. The media effort focuses on educating water users on drought stage restrictions and mandatory outdoor watering schedules. In the past, TRWD has covered the cost of printing sign materials for customer use throughout its service area.

Main Street Arts Festival Environmental Sponsorship

- The sponsorship gives the water district an opportunity to promote the "Save Water. Nothing can replace it." campaign at the largest four day event in the Southwest. And as an official sponsor, we can incorporate the save water message into the Main Street PR, marketing and advertising campaign leading up to the festival and throughout the event site.

  Some of the funding is used to support branded watering stations to dispense free, U/V filtered and refrigerated water to patrons with their own containers. A space for our mobile water conservation trailer is also provided.

Alliance for Water Efficiency Membership Tracking Tool

- Purchase Alliance for Water Efficiency annual membership for customer cities. One primary benefit of membership is "free" access to the AWE Water Conservation Tracking Tool.

The Tool is an Excel-based model that can evaluate the water savings, costs, and benefits of conservation programs for a specific water utility, using either English or Metric units. Using information entered into the Tool from the utility's system, it provides a standardized methodology for water savings and benefit-cost accounting, and includes a library of pre-defined conservation activities from which users can build conservation programs.

WaterWise 5th Grade Education Curriculum

- Educating future water users about water conservation is a key responsibility of water providers. The District partners with several communities on a shared-cost basis to provide 5th grade classes with the Water Wise educational toolkit. The program kits and activities put water knowledge and conservation center stage at school and at home. The kits provide "students and their families with the tools needed to audit and retrofit their homes with water saving devices. District partners include Arlington, Bedford, Fort Worth and North Richland Hills.

Additional Programs

- Water Conservation Workshops and program materials, Major Rivers Educational Curriculum for Forth Worth ISD middle school students, Water Conservation Regional Symposium, customer supported Home and Garden Shows.

Additional information on programs implemented by TRWD prior to 2009 can be found in the TCEQ Water Conservation Implementation Report in Appendix D. Refer to the report dated April 9, 2009.

8.3 In-House Water Conservation Efforts

TRWD has and will continue to implement and in-house water conservation program, including the following elements:

- Wherever possible, landscapes will use native or adapted drought tolerant plants, trees and shrubs.
- Irrigation at TRWD facilities will occur before 10 a.m. and after 6 p.m. year-round in order to lower losses due to evaporation.
- Irrigation will be limited to the amount needed to promote survival and health of plants and lawns. The Water District has eliminated irrigation at some pump station locations altogether.
- Irrigation will be avoided on Saturday and Sunday if possible, since these are periods of high water use by the public.
- Irrigation will be done with untreated source water wherever feasible and reasonable.

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9. ADOPTION AND AUTHORIZATION TO ENFORCE THE WATER CONSERVATION AND DROUGHT CONTINGENCY PLAN

Appendix K contains a copy of the minutes of the TRWD Board meeting at which this amended water conservation and drought contingency plan was adopted. The General Manager of TRWD is authorized to implement and enforce, to the extent provided herein, the water conservation and drought contingency plan. As discussed in Section 7.3 TRWD will prepare a water conservation report every year, incorporating the reports required from direct and indirect customers. This report will be used to review the effectiveness of TRWD's water conservation program, and results will be reported to the Advisory Committee and the TRWD board.

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10. REVIEW AND UPDATE OF WATER CONSERVATION PLAN

TCEQ requires that water conservation plans be updated prior to May 1, 2009 and every five years thereafter. TRWD will review and update this plan as appropriate based on new or updated information.

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11. DROUGHT CONTINGENCY PLAN

11.1 Introduction

The purpose of this drought contingency plan is as follows:

- To conserve the available water supply in times of drought and emergency
- To maintain supplies for domestic water use, sanitation, and fire protection
- To protect and preserve public health, welfare, and safety
- To minimize the adverse impacts of water supply shortages
- To minimize the adverse impacts of emergency water supply conditions.

As this plan is being prepared (February 2014), TRWD is in a Stage 1 drought. The lack of rainfall and runoff along with record breaking temperatures in previous years has dramatically affected lake levels. In response to the drought conditions, TRWD is updating its water conservation and drought contingency plans to take a more active role in educating the public about the importance of using water more efficiently, changing behaviors to reduce water waste, and working with the community to have a positive impact.

TRWD recognizes the need for developing a regional approach to implementing water conservation strategies. The Water District has worked closely with other water suppliers to create an educational outreach campaign with unified themes and messages. The campaign is designed to provide people with information and tools that can be used to save water. The extensive effort consists of multiple methods to reach and educate the public, including:

- Television ads
- Radio ads
- Transit ads
- Billboards
- Yard signs
- Newspaper and magazine ads
- Movie theater ads
- Fact sheets
- Web sites
- Social Media
- An ongoing print and media relations campaign with print and electronic media

- Other outreach programs, such as a traveling exhibit for community events and meetings with representatives of plumbing, landscape irrigation, nurseries, and other industries with influence on water use.

The specifics of the public outreach and education campaign will vary depending on the circumstances of future droughts, but this current example shows TRWD's commitment to an appropriate drought response.

11.2 State Requirements for Drought Contingency Plans

This drought contingency plan is consistent with the Texas Commission on Environmental Quality (TCEQ) guidelines and requirements for the development of drought contingency plans by wholesale water suppliers, contained in Title 30, Part 1, Chapter 288, Subchapter B, Rule 288.22 of the Texas Administrative Code. This rule is included in Appendix B.

Minimum Requirements

TCEQ's minimum requirements for drought contingency plans are addressed in the following subsections of this report:

- 288.22(a)(1) – Provisions to Inform the Public and Provide Opportunity for Public Input – Section 11.3
- 288.22(a)(2) – Coordination with the Regional Water Planning Group – Section 11.9
- 288.22(a)(3) – Criteria for Initiation and Termination of Drought Stages – Section 11.4
- 288.22(a)(4) – Drought and Emergency Response Stages – Section 11.5
- 288.22(a)(5) – Procedures for Initiation and Termination of Drought Stages – Section 11.5
- 288.22(a)(6) – Specific, Quantified Targets for Water Use Reductions – Section 11.5
- 288.22(a)(7) – Specific Measures to Be Implemented during Each Drought Stage – Section 11.5
- 288.22(a)(8) – Provision for Wholesale Contracts to Require Water Distribution According to Texas Water Code §11.039 – Sections 11.5 and 11.6.
- 288.22(a)(9) – Procedures for Granting Variances to the Plan – Section 11.7
- 288.22(a)(10) – Procedures for Enforcement of Mandatory Restrictions – Section 11.8
- 288.22(b) – Notification of Implementation of Mandatory Measures – Section 11.4
- 288.22(c) – Review and Update of Plan – Section 11.10

11.3 Provisions to Inform the Public and Opportunity for Public Input

TRWD provided opportunity for public input in the development of this drought contingency plan by the following means:

- Several meetings with customer representatives were held to discuss and coordinate the development of this plan.
- The District will provide the draft plan to anyone requesting a copy.
- The proposed plan was posted to SaveTarrantWater.com web site (May 5, 2014) providing the public an opportunity to review and comment on the plan in writing.
- Public comment was available at the Tarrant Regional Water District board meeting held at the District offices in Fort Worth, at the time of adoption.

This version of the drought contingency plan does include updates. Most of the 2009 drought contingency plan remains intact; however some measures and actions in this plan were modified in order to specifically match those contained in the plans of other North Texas water providers. The changes made to this plan are consistent with taking a regional approach to conserve water in times of drought or emergency. The regional effort to achieve consistency among water provider drought plans was a direct result of discussions among the region's largest water suppliers, including TRWD, Dallas Water Utilities (DWU), North Texas Municipal Water District (NTMWD), and Upper Trinity Regional Water District (UTRWD). The public was invited to submit its input at the Water District board meeting held at 9:30 a.m., on Tuesday, May 20, 2014. For those who wished to submit comments, but were unable to attend the meeting, TRWD posted this plan on its SaveTarrantWater.com Web site.

11.4 Initiation and Termination of Drought Response Stages

Initiation of Drought Response Stage

The General Manager may order the implementation of a drought response stage or water emergency when one or more water supply trigger conditions is met. The following actions will be taken when a drought stage is initiated:

- The designated representative(s) of primary wholesale customers will be notified by email, mail, telephone, or fax that provides details of the reasons for initiation of the drought stage.
- The public will be notified through local media following the notification of primary wholesale customers.
- If any mandatory provisions of the drought contingency plan are activated, TRWD will notify TCEQ within five business days.

Notwithstanding the foregoing, the General Manager may decide, under special circumstances, not to order the implementation of a drought response stage or water emergency even though one or more of the trigger criteria for the stage are met. Factors which could influence such a decision include, but are not limited to, the time of year,

weather conditions, the anticipation of replenished water supplies, or the anticipation that additional facilities will become available to meet needs.

The trigger conditions in this plan pertaining to TRWD's system volume were established following an intensive study of the North Texas climate and its impact on water supplies by Hydrosphere, an engineering firm based in Boulder, Colorado. The 2007 study projected the effects of simulated weather patterns on the combined storage capacity of TRWD reservoirs. Using computer simulations, Hydrosphere compared the water savings that would be achieved at various trigger points with and without outdoor watering restrictions in place. Under severe drought conditions, the estimated water savings that would be achieved by implementing this plan would extend water supplies by several weeks. A more detailed summary of the study's findings is included in Appendix M.

Termination of a Drought Stage

The General Manager will order the termination of a drought response stage or water emergency when the conditions for termination are met. The following actions will be taken when a drought stage is terminated:

- The designated representative(s) of primary wholesale customers will be notified by email, mail, telephone, or fax that provides details of the reasons for termination of the drought stage.
- The public will be notified through local media following the notification of primary wholesale customers.
- When mandatory provisions of the drought contingency plan that have been activated are terminated, TRWD will notify the Executive Director of the TCEQ within five business days.

Notwithstanding the foregoing, the General Manager may decide, under special circumstances, not to order the termination of a drought response stage or water emergency even though conditions for termination of the stage are met. Factors which could influence such a decision include, but are not limited to, the time of year, weather conditions, or the anticipation of potential changes in conditions that warrant the continuation of the drought stage.

11.5 Drought and Emergency Response Stages and Measures

Stage 1, Water Watch

Triggering and Terminating Conditions

- Total combined raw water supply in TRWD western and eastern division reservoirs drops below 75% (25% depleted) of conservation storage capacity.
- Water demand for all or part of the delivery system approaches delivery capacity because delivery capacity is inadequate.
- One or more of TRWD's water supply sources has become limited in availability.

- Water demand is projected to approach the limit of permitted supply.
- Supply source becomes contaminated.
- Water supply system is unable to deliver water due to the failure or damage of major water system components.
- The General Manager finds that conditions warrant the declaration of a Stage 1 drought.

Subject to preceding paragraphs regarding the Termination of a Drought Response stage, Stage 1, Water Watch, will be terminated when the total combined raw water supply in TRWD's western and eastern division reservoirs exceeds 95% of conservation storage or remains above 85% for 90 consecutive days, whichever occurs first.

Goal for Use Reduction

The goal for water use reduction under Stage 1, Water Watch, is to decrease use by five percent. If circumstances warrant, the General Manager can set a goal for greater water use reduction.

Water Use Reduction Actions under Stage 1, Water Watch

The General Manager may order the implementation of any of the actions listed below, as deemed necessary. Measures imposing mandatory requirements on customers require notification to TCEQ. TRWD must notify TCEQ within five business days if any mandatory measures are implemented.

- Require customers (including indirect customers) to initiate Stage 1 in their drought contingency plans. Indirect customers include any successive wholesale customers of TRWD's primary wholesale customers to the extent provided for in water sales contracts.

All Water Users

- Maximum of twice per week watering for hose-end sprinklers and automatic irrigation systems based on odd/even addresses and day of week schedule.

Stage 1, Water Watch, Outdoor Watering Schedules		
Monday	No Outdoor Watering	Water System Recovery Day
Tuesday and Friday	Non-Residential Sites	Apartments, Parks, Common Areas, HOA's, Businesses
Wednesday and Saturday	Residential Addresses Ending in Even Numbers	0,2,4,6,8
Thursday and Sunday	Residential Addresses Ending in Odd Numbers	1,3,5,7,9

Exceptions:

- Watering with a handheld hose, soaker hose or drip irrigation may occur any day and any time.
- Watering of trees and structural foundations may occur any day and any time by means of handheld hose, soaker hose, or drip irrigation.
- The use of water necessary to protect the health, safety, or welfare of the public.
- Water use necessary for the repair of an irrigation system, plumbing line, fountain, etc. in the presence of person making repair.
- Variances may be available through the District for the following:
    - Establishing new turfgrass and/or landscaping. Variances granted for establishing new turfgrass or landscaping will be for a maximum of 30 days from the date of approval then maximum of twice per week watering schedule applies.
    - Variances do not apply to the installation (over seeding) of cool season grasses.
    - Outdoor watering at addresses with large multi-station irrigation systems may take place in accordance with a variance granted by the District, if the District determines that a property cannot be completely irrigated under the twice per week schedule. Under such variance, no irrigation station will be allowed to water more than twice per week.
    - Areas open to the public and have high-impact from frequent use may be allowed additional watering with a variance granted by the District if it is deemed to be beneficial to serve and protect the community facility or amenity.
    - Restrictions do not apply to locations using well water, reclaimed water, or other alternative water sources.

- No watering with hose-end sprinklers and/or automatic spray irrigation systems between the hours of 10 a.m. and 6 p.m.
- Prohibit using water in such a manner as to allow runoff or other waste, including:
    - failure to repair a controllable leak, including, broken sprinkler heads, leaking valves, leaking or broken pipes or faucets;
    - operating an irrigation system with: (a) a broken head; (b) a head that is out of adjustment and spraying into the street, parking area, or sidewalk; or (c) a system that is misting/fogging due to excessive water pressure; or

  - allowing any water to: (a) run off property forming a stream of water for a distance of 50 feet or greater; (b) run into a storm drain; or (c) pond to a depth of ¼ inch or greater; or
  - allowing or causing an irrigation system or other lawn watering device to operate during any form of precipitation or when temperatures are at or below 32 degrees Fahrenheit.

- All users are encouraged to use native and adapted drought tolerant plants in landscaping.
- Discourage hosing of paved areas.
- Discourage hosing of buildings or other structures for purposes other than fire protection or surface preparation prior to painting or maintenance.
- Washing of any motor vehicle, motorbike, boat, trailer, airplane, or other vehicle shall be limited to the use of a hand-held bucket or a hand-held hose equipped with a positive-pressure shutoff nozzle for quick rinses. Vehicle washing may be done at any time on the premises of a commercial car wash or commercial service station. Companies with automated on-site vehicle washing facilities may wash its vehicles at any time.
- Discourage the filling, draining, or refilling of swimming pools, wading pools, hot tubs and Jacuzzi type pools except to maintain adequate water levels for structural integrity, proper operation and maintenance, and/or to alleviate an issue that poses a public safety risk.

<u>City and Local Governments</u>

- Review conditions and problems that caused Stage 1. Take corrective action.
- Increase public education efforts on ways to reduce water use.
- Increase enforcement efforts.
- Intensify leak detection and repair efforts.
- Audit all city and local government irrigation systems to ensure proper condition, settings, and operation.
- Identify and encourage voluntary reduction measures by high-volume water users through water use audits.
- Landscape watering of municipal parks, golf courses and athletic fields is restricted to a twice per week watering schedule; or twice per week per irrigation station if a variance is granted by the Water District. (See exceptions to outdoor watering restrictions in all water users category above for facilities with large multi-station irrigation systems.)

Exceptions:

- Golf courses may water greens and tee boxes as necessary, however, use of spray irrigation may not be done between 10 a.m. and 6 p.m. Encouraged to reduce water use by five percent.
- Watering of athletic fields (field only, does not include surrounding landscaped areas) used for organized sports practice, competition, or exhibition events may occur as necessary to protect the health and safety of the players, staff, or officials present for athletic events. Encouraged to reduce water use by five percent.

- Reduce non-essential water use. As used herein, non-essential water uses are those that do not have a health or safety impact and are not needed to meet the core function of the agency.
- Notify wholesale customers of actions being taken and request them to implement the same drought stage and measures.

Commercial or Industrial

- All actions listed above for all water users apply to commercial and industrial users.
- Landscape watering of parks, golf courses and athletic fields is restricted to the twice per week watering schedule; or twice per week per irrigation station if a variance is granted by the water provider. (See exceptions to outdoor watering restrictions in all water users category above for facilities with large multi-station irrigation systems.)

  Exceptions:

  - Golf courses may water greens and tee boxes as necessary, however, use of spray irrigation may not be done between 10 a.m. and 6 p.m. Encouraged to reduce water use by five percent.
  - Watering of athletic fields (field only, does not include surrounding landscaped areas) used for organized sports practice, competition, or exhibition events may occur as necessary to protect the health and safety of the players, staff, or officials present for athletic events. Encouraged to reduce water use by 5 five percent.

- Stock at commercial plant nurseries is exempt from Stage 1 watering restrictions.
- Hotels, restaurants, and bars are encouraged to serve drinking water to patrons per request only.
- Hotels are encouraged to implement laundry conservation measures by encouraging patrons to reuse linens and towels.
- Car wash facilities must keep equipment in good working order, which should include regular inspections to be sure there are no leaks, broken or misdirected nozzles, and that all equipment is operating efficiently.

- All commercial and industrial customers are encouraged to audit irrigation systems to ensure proper condition, settings, and operation. If irrigation audit or repair occurs during restricted watering times or days, a sign indicating such work is taking place must be placed in public view until job is completed.

Stage 2, Water Warning

Triggering and Terminating Conditions

- Total raw water supply in TRWD western and eastern division reservoirs drops below 60% (40% depleted) of conservation storage capacity.
- Water demand for all or part of the delivery system approaches delivery capacity because delivery capacity is inadequate.
- One or more of TRWD's water supply sources has become limited in availability.
- Water demand is projected to approach the limit of permitted supply.
- Supply source becomes contaminated.
- Water supply system is unable to deliver water due to the failure or damage of major water system components.
- The General Manager finds that conditions warrant the declaration of a Stage 2 drought.

Subject to preceding paragraphs regarding the Termination of a Drought Response stage, Stage 2, Water Warning, will be terminated when the Total combined raw water supply in TRWD's western and eastern division reservoirs exceeds 75% of conservation storage or remains at or above 70% for 30 consecutive days, whichever occurs first.

Goal for Use Reduction

The goal for water use reduction under Stage 2, Water Warning, is to decrease use by 10 percent. If circumstances warrant, the General Manager can set a goal for greater water use reduction.

Water Use Reduction Actions under Stage 2, Water Warning

The General Manager may order the implementation of any of the actions listed below, as deemed necessary. Measures imposing mandatory requirements on customers require notification to TCEQ. TRWD must notify TCEQ within five business days if any mandatory measures are implemented.

- Continue actions under Stage 1.
- Require customers (including indirect customers) to initiate Stage 2 in their drought contingency plans. Indirect customers include any wholesale customer of TRWD's primary wholesale customers to the extent provided for in water sales contracts.

- Initiate engineering studies to evaluate water supply alternatives should conditions worsen.

All Water Users

- Maximum of once per week watering for hose-end sprinklers and automatic irrigation systems at each service address.
- An effort will be made by TRWD and its primary customers to coordinate once per week watering schedules to simplify messages passed to customers through the news media. However, due to the variation in water storage and delivery systems of TRWD customers, specific watering days per address may vary across TRWD's service area.

  Exceptions:

  - Watering with a handheld hose, soaker hose or drip irrigation may occur any day and any time.
  - Watering of trees and structural foundations may occur any day and any time by means of handheld hose, soaker hose, or drip irrigation.
  - Variances may be available through the District for the following:
    - All users are encouraged to wait until the current drought or emergency situation has passed before establishing new landscaping. Variances granted for establishing new turfgrass or landscaping will be for a maximum of 30 days from the date of approval then maximum of once-per-week watering schedule applies.
    - Variances do not apply to the installation (over seeding) of cool season grasses.
    - Outdoor watering at addresses with large multi-station irrigation systems may take place in accordance with a variance granted by the District, if the District determines that a property cannot be completely irrigated under the once per week schedule. Under such variance, no irrigation station will be allowed to water more than once per week.
    - Areas open to the public and have high-impact from frequent use may be allowed additional watering with a variance granted by the District if it is deemed to be beneficial to serve and protect the community facility or amenity.
    - Restrictions do not apply to well water, reclaimed water, or other alternative water sources.
- Encourage the use of covers for all types of pools, hot tubs, and Jacuzzi type pools when not in use.

City and Local Governments

In addition to the actions listed above:

- Continue actions under Stage 1.
- Review conditions or problems that caused Stage 2. Take corrective action.
- Increase frequency of media releases on water supply conditions.
- Further accelerate public education efforts on ways to reduce water use.
- Landscape watering of municipal parks, golf courses and athletic fields is restricted to a once-per-week schedule; or once-per-week per irrigation station if a variance is granted by the water provider. (See Stage 1 exceptions to outdoor watering restrictions in all water users category for facilities with large multi-station irrigation systems.)

  Exceptions:

  - Golf courses may water greens and tee boxes as necessary, however, use of spray irrigation may not be done between 10 a.m. and 6 p.m. Encouraged to reduce water use by ten percent.
  - Watering of athletic fields (field only, does not include surrounding landscaped areas) used for organized sports practice, competition, or exhibition events may occur as necessary to protect the health and safety of the players, staff, or officials present for athletic events. Encouraged to reduce water use by ten percent.

- Eliminate non-essential water use. As used herein, non-essential water uses are those that do not have any health or safety impact and are not needed to meet the core function of the agency.
- Notify wholesale customers of actions being taken and request them to implement the same drought stage and measures.

Commercial or Industrial

- All actions listed above for all water users apply to commercial and industrial users.
- Landscape watering of municipal parks, golf courses and athletic fields is restricted to a once-per-week schedule; or once-per-week per irrigation station if a variance is granted by the water provider. (See Stage 1 exceptions to outdoor watering restrictions in all water users category for rules that apply to facilities with large multi-station irrigation systems.)

  Exceptions:

  - Golf courses may water greens and tee boxes as necessary, however, use of spray irrigation may not be done between 10 a.m. and 6 p.m. Encouraged to reduce water use by ten percent.

- Watering of athletic fields (field only, does not include surrounding landscaped areas) used for organized sports practice, competition, or exhibition events may occur as necessary to protect the health and safety of the players, staff, or officials present for athletic events. Encouraged to reduce water use by ten percent.

Stage 3, Water Emergency

Triggering and Terminating Conditions

- Total raw water supply in TRWD western and eastern division reservoirs drops below 45% (55% depleted) of conservation storage capacity.
- Water demand exceeds the amount that can be delivered to customers.
- Water demand for all or part of the TRWD delivery system approaches delivery capacity because delivery capacity is inadequate.
- One or more of TRWD's water supply sources has become limited in availability.
- Water demand is projected to approach the limit of permitted supply.
- Supply source becomes contaminated.
- Water supply system is unable to deliver water due to the failure or damage of major water system components.
- The General Manager finds that conditions warrant the declaration of a Stage 3 drought.

Subject to preceding paragraphs regarding the Termination of a Drought Response stage, Stage 3, Water Emergency, will be terminated when the total combined raw water supply in TRWD's western and eastern division reservoirs exceeds 60% of conservation storage or remains at or above 55% for 30 consecutive days, whichever occurs first.

Goal for Use Reduction

The goal for water use reduction under Stage 3, Water Emergency, is to decrease use by 20 percent. If circumstances warrant, the General Manager can set a goal for greater water use reduction.

Actions Available under Stage 3, Water Emergency

The General Manager can order the implementation of any of the actions listed below, as deemed necessary. Measures imposing mandatory requirements on customers require notification to TCEQ. TRWD must notify TCEQ within five business days if these measures are implemented.

- Continue actions under Stages 1 and 2.
- Require customers (including indirect customers) to initiate Stage 3 in their drought contingency plans. Indirect customers include any wholesale customer of

TRWD's primary wholesale customers to the extent provided for in water sales contracts. .

All Water Users

- Prohibit all outdoor watering with hose-end sprinklers and automatic irrigation systems, including at parks, golf courses, and sports fields.

  Exceptions:

  - Watering with hand-held hose, soaker hose or drip irrigation system may occur any day and any time.
  - Watering of trees and structural foundations may occur any day and any time by means of handheld hose, soaker hose, or drip irrigation.
  - Restrictions do not apply to well water, reclaimed water, or other alternative water sources.
  - Irrigation of new landscapes and/or turfgrass installations is prohibited by means of automatic irrigation system or hose-end sprinkler. Variances may be granted for those landscape projects started prior to the initiation of stage 3 drought restrictions. However, variances will not be granted for the irrigation of new landscape and/or turfgrass installations after the initiation of Stage 3 drought restrictions.
  - Prohibit washing of paved areas by any means except where a variance is granted to alleviate a possible public health and safety risk. Any pressure/power washing activities must be performed by a professional pressure/power washing service provider utilizing high efficiency equipment and a vacuum recovery system where possible.
  - Prohibit hosing of buildings or other structures for purposes other than fire protection or surface preparation prior to painting with high-pressure equipment. Services must be performed by a professional pressure/power washing service provider utilizing high efficiency equipment and a vacuum recovery system where possible.
  - Vehicle washing is restricted to commercial car washes, commercial service stations, or professional washing services only. This includes home and charity car washing. The washing of garbage trucks and vehicles used to transport food and/or other perishables may take place as necessary for health, sanitation, or public safety reasons.
  - Prohibit permitting of private pools. Pools already permitted may be completed and filled. Existing private and public pools may add water to maintain pool levels, but may not be drained and refilled.
  - Prohibit the operation of ornamental fountains or ponds that use potable water except where necessary to support aquatic life or water quality.
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City and Local Governments

- Continue actions under Stages 1 and 2.
- Review conditions or problems that caused Stage 3. Take corrective action.
- Increase frequency of media releases explaining emergency situation and/or water supply conditions. .
- Landscape watering at municipal parks, golf courses, and sports fields is prohibited. Variances may be granted by the water provider under special circumstances.

  Exceptions:

  - Golf course greens and tee boxes may be watered by hand as necessary.
  - Variances may be available for watering of athletic fields (field only, does not include surrounding landscaped areas) used for organized sports practice, competition, or exhibition events to protect the health and safety of the players, staff, or officials present for the athletic event.
  - Professional and college sports fields (playing fields with a stadium only – not surrounding landscaping) may be watered as necessary to maintain league standards.
- Institute a mandated reduction in deliveries to all wholesale customers. Such a reduction will be distributed as required by Texas Water Code §11.039.
- If TRWD has imposed a reduction in water available to customers, impose the same percent reduction on wholesale customers.

Commercial or Industrial

- All actions listed above for all water users apply to commercial and industrial users. Landscape watering of municipal parks, golf courses and athletic fields is prohibited. Variances may be granted by the water provider under special circumstances.

  Exceptions:

  - Golf course greens and tee boxes may be watered by hand, as necessary.
  - Variances may be available for watering of athletic fields (field only, does not include surrounding landscaped areas) used for organized sports practice, competition, or exhibition events to protect the health and safety of the players, staff, or officials present for the athletic event.
- Professional and college sports fields (playing fields with a stadium only – not surrounding landscaping) may be watered as necessary to maintain league standards.

- Require hotels, restaurant, and bars to serve drinking water to patrons on an "on demand" basis.
- Require hotels to implement laundry conservation measures by encouraging patrons to reuse linens and towels.
- Stock at commercial plant nursery may be watered by hand only with a handheld hose, hand-held watering can, soaker hose, or drip irrigation system.
- Commercial and industrial water users may be required to reduce water use by a set percentage as determined by the Water District.

11.6 Procedure for Curtailment of Water Supplies

Any mandatory reduction to deliveries from TRWD to its customers shall be distributed as required by Texas Water Code §11.039, which is attached as Appendix N. In addition, every wholesale water supply contract entered into or renewed after adoption of this plan, including contract extensions, shall include a provision that water will be distributed in accordance with the Texas Water Code §11.039 in case of a water shortage resulting from drought.

To the extent not prevented by enforcement of provisions in the Water District's wholesale contracts in effect before November 28, 1999, TRWD will implement pro rata curtailment of water deliveries pursuant to Texas Water Code §11.039.

11.7 Procedure for Granting Variances to the Plan

The General Manager may grant temporary variances for existing water uses otherwise prohibited under this drought contingency plan to a customer if one or more of the following conditions are met:

- Failure to grant such a variance would cause an emergency condition adversely affecting health, sanitation, or fire safety for the public or the person requesting the variance.
- Compliance with this plan cannot be accomplished due to technical or other limitations.
- Alternative methods that achieve the same level of reduction in water use can be implemented.

Variances shall be granted or denied at the discretion of the General Manager. All petitions for variances should be in writing and should include the following information:

- Name and address of petitioner(s)
- Purpose of water use
- Specific provisions from which relief is requested
- Detailed statement of the adverse effect of the provision from which relief is requested

- Description of the relief requested
- Period of time for which the variance is sought
- Alternative measures that will be taken to reduce water use
- Other pertinent information.

11.8 Procedure for Enforcing Mandatory Water Restrictions

Water District customers (direct and indirect) shall provide TRWD with an order, ordinance, or resolution to demonstrate adequate enforcement provisions for the customer's own drought contingency plan.

Mandatory water use restrictions may be imposed in Stage 1, Stage 2, and Stage 3 drought stages. These mandatory water use restrictions will be enforced by warnings and penalties as follows:

- On the first violation, the customer will be given a written warning that they have violated one or more of the mandatory water use restrictions.
- After a second violation, TRWD will notify the customer of its intent to publish the name and contact phone numbers of any entity in violation of this water conservation and drought contingency plan in local print media and on its Web site. In addition, TRWD will require the customer to implement a more comprehensive public education and outreach program in a manner that increases the public's awareness about mandatory water use restrictions and the current drought status. The customer will also be required to submit documentation to TRWD of the steps it has taken to ensure compliance with this water conservation and drought contingency plan within 90 days after receiving the second notice of violation.
- TRWD may petition the Texas Commission on Environmental Quality to initiate formal enforcement action against customers that repeatedly fail to comply with the mandatory water use restrictions implemented during any stage of this water conservation and drought contingency plan.

11.9 Coordination with the Regional Water Planning Groups

Appendix L includes copies of letters sent to the Chairs of the Region C and Region D water planning group with this water conservation and drought contingency plan.

11.10 Review and Update of Drought Contingency Plan

As required by TCEQ rules, TRWD reviewed this drought contingency plan in 2014 and will do so every five years thereafter. The plan will be updated as appropriate based on new or updated information.

11.11 Drought Contingency Plan Definitions

Term	Definition
Aesthetic Water Use	Water use for ornamental or decorative features, such as fountains, reflecting pools, and water gardens.
Alternative Water Source	Water produced by a source other than a water treatment plant and is not considered potable. These sources can include, but are not limited to: reclaimed/recycled water, collected rain water, collected grey water, private well water.
Athletic field	A sports playing field, the essential feature of which is turf grass, used primarily for organized sports for schools, professional sports, or sanctioned league play.
Automatic Irrigation System	A site specific system of delivering water generally for landscaping via a system of pipes or other conduits installed below ground that automatically cycles water use through water emitters to a preset program, whether on a designated timer or through manual operation.
Aquatic Life	A vertebrate organism dependent upon an aquatic environment to sustain its life.
Conservation	Those practices, techniques, and technologies that reduce water consumption; reduce the loss or waste of water; improve the efficiency in water use; and increase the recycling and reuse of water so that supply is conserved and made available for other or future uses.
Customer	Any person, company, or organization using water supplied by TRWD or through an entity supplied by TRWD.
Drip irrigation	An irrigation system (drip, porous pipe, etc.) that applies water at a predetermined controlled low-flow levels directly to the roots of the plant
Drought Contingency Plan	A strategy or combination of strategies for temporary supply management and demand management responses to temporary or potentially recurring water supply shortages and other water supply emergencies.

Term	**Definition**
Fountain	An artificially created jet, stream or flow of water, a structure, often decorative, from which a jet, stream or flow of water issues.
Golf Course	An irrigated and landscaped playing area made up of greens, tees, fairways, roughs and related areas used for the playing of golf.
Hand-held hose	A hose physically held by one person, fitted with a manual or automatic shutoff nozzle.
Hose-end Sprinkler	A device through which water flows from a hose to a sprinkler to water any lawn or landscape.
Hosing	To spray, water, or wash with a water hose.
Irrigation system	A system of fixed pipes and water emitters that apply water to landscape plants or turfgrass, including, but not limited to: in-ground and permanent irrigation systems.
Lake, lagoon, or pond	Artificially created body of fresh or salt water.
Landscape irrigation use	Water used for the irrigation and maintenance of landscaped areas, whether publicly or privately owned, including residential and commercial lawns, gardens, golf courses, parks, right-of-ways, medians and entry ways.
"New landscape"	A landscape: a. Installed during construction of a new house, multi-family dwelling, or commercial building; b. Installed as part of a governmental entity's capital improvement project; or Alters more than one-third the area of an existing landscape.

Term	**Definition**
Non-essential water use	Water uses that are not required for the protection of public health, safety and welfare, such as: a. Irrigating landscape areas, including parks, athletic fields, and golf courses, except as otherwise provided under this plan; b. Washing any sidewalks, walkways, driveways, parking lots, tennis courts, or other hard-surfaced areas; except to alleviate a public health and safety issue; c. Washing any automobile, motorbike, boat (and/or trailer), airplane, or other vehicle except where required by law for safety and sanitary purposes. d. Washing buildings or structures for purposes other than immediate fire protection, or other uses provided under this plan; e. Filling, refilling, or adding to any swimming pools or Jacuzzi-type pools, except to maintain safe operating levels; f. Filling or operation of a fountain or pond for aesthetic or scenic purposes except when necessary to support aquatic life; g. Failure to repair a controllable leak within a reasonable time period after being directed to do so by formal notice; and h. Drawing from hydrants for construction purposes or any other purpose other than firefighting or protection of public drinking water supplies.
Park	A non-residential or multifamily tract of land, other than a golf course, maintained by a city, private organization, or individual, as a place of beauty or public recreation and available for use to the general public.
Power/Pressure washer	A machine that uses water or a water-based product applied at high pressure to clean impervious surfaces.
Power/Pressure washer (High-Efficiency)	A machine that uses water or a water-based product applied at 1500 pounds per square inch (PSI) or greater.

Term	**Definition**
Reclaimed Water	Municipal wastewater effluent that is given additional treatment and distributed for reuse in certain applications. Also referred to as recycled water.
Soaker hose	A flexible hose that is designed to slowly emit water across the entire length and connect directly to a flexible hose or spigot. Does not include hose that by design or use sends a fine spray in the air. It is not considered drip irrigation.
Structural Foundation	The lowest and supporting layer of a structure.
Swimming pool	Any structure, basin, chamber, or tank including hot tubs, containing an artificial body of water for swimming, diving, or recreational bathing, and having a depth of two (2) feet or more at any point.
Well Water	Water that has been, or is, obtained from the ground by digging, boring, or drilling to access an underground aquifer.

APPENDIX A
LIST OF REFERENCES

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Appendix A

List of References

(1) Title 30 of the Texas Administrative Code, Part 1, Chapter 288, Subchapter A, Rules 288.1, 288.2 and 288.5, downloaded from http://info.sos.state.tx.us/pls/pub/readtac$ext.ViewTAC?tac_view=5&ti=30&pt=1&ch=288&sch=A&rl=Y , May 2014.

(2) Title 30 of the Texas Administrative Code, Part 1, Chapter 288, Subchapter B, Rule 288.20 and 288.22, downloaded from http://info.sos.state.tx.us/pls/pub/readtac$ext.ViewTAC?tac_view=5&ti=30&pt=1&ch=288&sch=B&rl=Y , May 2014.

(3) Texas Water Development Board, Report 362, "Water Conservation Best Management Practices Guide," Water Conservation Implementation Task Force, available online at http://www.twdb.state.tx.us/assistance/conservation/TaskForceDocs/WCITFBMPGuide.pdf, November 2004.

(4) Edward Motley, Marisa Vergara, Tom Gooch, and Stephanie Griffin: Memorandum to File on "Region C Municipal Water Use Projections Adopted on August 18, 2003," Fort Worth, August 21, 2003.

(5) North Central Texas Council of Governments, "2014 Current Population Estimates," Arlington, available through the Cooperative Data Program: www.nctcorg/ris/cdp/aboutus.aspx , April 2014.

(6) Texas Water Development Board and Water Conservation Implementation Task Force, "Special Report, Report to the 79th Legislature, Austin, available online http://www.twdb.state.tx.us/assistance/conservation/TaskForceDocs/WCITF_Leg_Report.pdf, November 2004.

This water conservation and drought contingency plan was largely adapted from the following two plans:

a. North Texas Municipal Water District: "Water Conservation and Drought Contingency Plan," prepared by Freese and Nichols, Inc., Fort Worth, August 2004 with revisions in April 2006.

b. Tarrant Regional Water District: "Water Conservation and Drought Contingency Plan," originally developed by HDR Engineering, Inc., Austin, June 1998 and updated by TRWD in April 2005.

The following conservation and drought contingency plans and related documents were reviewed in the development of the North Texas Municipal Water District (NTMWD) plan cited above. References marked with a * were used heavily in the development of the NTMWD plan.

c. City of Austin Water Conservation Division: "City of Austin Water Drought Contingency Plan, Developed to Meet Senate Bill 1 Regulatory Requirements," Austin, August 1999.

d. City of Austin Water Conservation Division: "City of Austin Water Conservation Plan, Developed to Meet Senate Bill 1 Regulatory Requirements," Austin, August 1999.

e. Upper Trinity Regional Water District: "Water Conservation Plan and Emergency Water Demand Management Plan," adopted by the Board of Directors, Lewisville, August 5, 1999.

f. Upper Trinity Regional Water District: "Water Conservation Plan and Emergency Water Demand Management Plan (2002 Amended)," adopted by the Board of Directors, Lewisville, February 2002.

g. *City of Dallas Water Utilities Department: "City of Dallas Water Management Plan," adopted by the City Council, Dallas, September 1999.

h. Updates to City of Dallas Water Management Plan found at http://www.dallascityhall.com in September 2003.

i. City of Dallas Water Utilities Department: "City of Dallas Water Conservation Plan," adopted by the City Council, Dallas, September 1999.

j. City of Fort Worth: "Water Conservation plan for the City of Fort Worth," Fort Worth, August 1999.

k. Updates to the City of Fort Worth water conservation plan found at http://ci./fort-worth.tx.us in September 2003.

l. *City of Fort Worth: "Emergency Water Management Plan for the City of Fort Worth," Fort Worth, August 19, 2003.

m. HDR Engineering, Inc.: "Water Conservation and Emergency Demand Management Plan," prepared for the Tarrant Regional Water District, Austin, February 2000.

n. Freese and Nichols, Inc.: "Water Conservation and Drought Contingency Plan," prepared for Brown County Water Improvement District No. 1, Fort Worth, August 1999.

o. Freese and Nichols, Inc.: "Water Conservation and Drought Contingency Plan," prepared for the Sabine River Authority of Texas, Fort Worth, September 1994.

p. HDR Engineering, Inc.: "Water Conservation and Emergency Demand Management Plan," prepared for the Tarrant Regional Water District, Austin, June 1998.

q. HDR Engineering, Inc.: "Water Conservation Plan for the City of Corpus Christi," adopted by the City of Corpus Christi City Council, August 24, 1999.

r. City of Houston's water conservation plan downloaded September 2003 from http://www.cityofhouston.gov

s. City of Houston: "Ordinance N. 2001-753, Amending Chapter 47 of the Code of Ordinances Relating to Water Emergencies," Houston, August 2001.

t. City of Houston: "Ordinance No. 98-764, Relating to Water Conservation," Houston, September 1998.

u. City of Houston: "Water Conservation Plan," 1998.

v. City of Houston: "Water Emergency Response Plan," Houston, July 15, 1998.

w. City of Lubbock: "Water Conservation Plan," ordinance number 10177 adopted by the City Council in August 1999.

x. City of El Paso Water Conservation Ordinance downloaded August 14, 2003 from http://www.epwu.org/ordinance.html

y. San Antonio Water System: "Water Conservation and Reuse Plan," San Antonio, November 1998 with June 2002 updates.

z. *North Texas Municipal Water District: "District Policy No. 24 Water Conservation Plan Containing Drought Contingency Plan," adopted August 1999.

aa. GDS Associates, Inc.: "Water Conservation Study," prepared for the Texas Water Development Board, Fort Worth, 2002.

bb. A & N Technical Services, Inc.: "BMP Costs & Savings Study: A Guide to Data and Methods for Cost-Effectiveness Analysis of Urban Water Conservation Best Management Practices," prepared for The California Urban Water Conservation Council, Santa Monica, California, July 2000.

cc. City of Dallas: "City of Dallas Ordinances, Chapter 49, Section 21.1," Dallas, October 1, 2001.

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APPENDIX B

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY RULES ON WATER CONSERVATION AND DROUGHT CONTINGENCY PLANS FOR MUNICIPAL AND WHOLESALE WATER PROVIDERS

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APPENDIX B

Texas Commission on Environmental Quality Rules on Water Conservation and Drought Contingency Plans for Wholesale Water Suppliers

Texas Administrative Code

TITLE 30	ENVIRONMENTAL QUALITY
PART 1	TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
CHAPTER 288	WATER CONSERVATION PLANS, DROUGHT CONTINGENCY PLANS, GUIDELINES AND REQUIREMENTS
SUBCHAPTER A	WATER CONSERVATION PLANS
RULE §288.1	**Definitions**

The following words and terms, when used in this chapter, shall have the following meanings, unless the context clearly indicates otherwise.

(1) Agricultural or Agriculture--Any of the following activities:

(A) cultivating the soil to produce crops for human food, animal feed, or planting seed or for the production of fibers;

(B) the practice of floriculture, viticulture, silviculture, and horticulture, including the cultivation of plants in containers or non-soil media by a nursery grower;

(C) raising, feeding, or keeping animals for breeding purposes or for the production of food or fiber, leather, pelts, or other tangible products having a commercial value;

(D) raising or keeping equine animals;

(E) wildlife management; and

(F) planting cover crops, including cover crops cultivated for transplantation, or leaving land idle for the purpose of participating in any governmental program or normal crop or livestock rotation procedure.

(2) Agricultural use--Any use or activity involving agriculture, including irrigation.

(3) Best management practices--Voluntary efficiency measures that save a quantifiable amount of water, either directly or indirectly, and that can be implemented within a specific time frame.

(4) Conservation--Those practices, techniques, and technologies that reduce the consumption of water, reduce the loss or waste of water, improve the efficiency in the use of water, or increase the recycling and reuse of water so that a water supply is made available for future or alternative uses.

(5) Commercial use--The use of water by a place of business, such as a hotel, restaurant, or office building. This does not include multi-family residences or agricultural, industrial, or institutional users.

(6) Drought contingency plan--A strategy or combination of strategies for temporary supply and demand management responses to temporary and potentially recurring water supply shortages and other water supply emergencies. A drought contingency plan may be a separate document identified as such or may be contained within another water management document(s).

(7) Industrial use--The use of water in processes designed to convert materials of a lower order of value into forms having greater usability and commercial value, and the development of power by means other than hydroelectric, but does not include agricultural use.

(8) Institutional use--The use of water by an establishment dedicated to public service, such as a school, university, church, hospital, nursing home, prison or government facility. All facilities dedicated to public service are considered institutional regardless of ownership.

(9) Irrigation--The agricultural use of water for the irrigation of crops, trees, and pastureland, including, but not limited to, golf courses and parks which do not receive water from a public water supplier.

(10) Irrigation water use efficiency--The percentage of that amount of irrigation water which is beneficially used by agriculture crops or other vegetation relative to the amount of water diverted from the source(s) of supply. Beneficial uses of water for irrigation purposes include, but are not limited to, evapotranspiration needs for vegetative maintenance and growth, salinity management, and leaching requirements associated with irrigation.

(11) Mining use--The use of water for mining processes including hydraulic use, drilling, washing sand and gravel, and oil field re-pressuring.

(12) Municipal use--The use of potable water provided by a public water supplier as well as the use of sewage effluent for residential, commercial, industrial, agricultural, institutional, and wholesale uses.

(13) Nursery grower--A person engaged in the practice of floriculture, viticulture, silviculture, and horticulture, including the cultivation of plants in containers or nonsoil media, who grows more than 50% of the products that the person either sells or leases, regardless of the variety sold, leased, or grown. For the purpose of this definition, grow means the actual cultivation or propagation of the product beyond the mere holding or maintaining of the item prior to sale or lease, and typically includes activities associated with the production or multiplying of stock such as the development of new plants from cuttings, grafts, plugs, or seedlings.

(14) Pollution--The alteration of the physical, thermal, chemical, or biological quality of, or the contamination of, any water in the state that renders the water harmful, detrimental, or injurious to humans, animal life, vegetation, or property, or to the public health, safety, or welfare, or impairs the usefulness or the public enjoyment of

the water for any lawful or reasonable purpose.

(15) Public water supplier--An individual or entity that supplies water to the public for human consumption.

(16) Residential use--The use of water that is billed to single and multi-family residences, which applies to indoor and outdoor uses.

(17) Residential gallons per capita per day--The total gallons sold for residential use by a public water supplier divided by the residential population served and then divided by the number of days in the year.

(18) Regional water planning group--A group established by the Texas Water Development Board to prepare a regional water plan under Texas Water Code, §16.053.

(19) Retail public water supplier--An individual or entity that for compensation supplies water to the public for human consumption. The term does not include an individual or entity that supplies water to itself or its employees or tenants when that water is not resold to or used by others.

(20) Reuse--The authorized use for one or more beneficial purposes of use of water that remains unconsumed after the water is used for the original purpose of use and before that water is either disposed of or discharged or otherwise allowed to flow into a watercourse, lake, or other body of state-owned water.

(21) Total use--The volume of raw or potable water provided by a public water supplier to billed customer sectors or nonrevenue uses and the volume lost during conveyance, treatment, or transmission of that water.

(22) Total gallons per capita per day (GPCD)--The total amount of water diverted and/or pumped for potable use divided by the total permanent population divided by the days of the year. Diversion volumes of reuse as defined in this chapter shall be credited against total diversion volumes for the purposes of calculating GPCD for targets and goals.

(23) Water conservation plan--A strategy or combination of strategies for reducing the volume of water withdrawn from a water supply source, for reducing the loss or waste of water, for maintaining or improving the efficiency in the use of water, for increasing the recycling and reuse of water, and for preventing the pollution of water. A water conservation plan may be a separate document identified as such or may be contained within another water management document(s).

(24) Wholesale public water supplier--An individual or entity that for compensation supplies water to another for resale to the public for human consumption. The term does not include an individual or entity that supplies water to itself or its employees or tenants as an incident of that employee service or tenancy when that water is not resold to or used by others, or an individual or entity that conveys water to another individual or entity, but does not own the right to the water which is conveyed, whether or not for a delivery fee.

(25) Wholesale use--Water sold from one entity or public water supplier to other retail

water purveyors for resale to individual customers.

Source Note: The provisions of this §288.1 adopted to be effective May 3, 1993, 18 TexReg 2558; amended to be effective February 21, 1999, 24 TexReg 949; amended to be effective April 27, 2000, 25 TexReg 3544; amended to be effective August 15, 2002, 27 TexReg 7146; amended to be effective October 7, 2004, 29 TexReg 9384; amended to be effective January 10, 2008, 33 TexReg 193; amended to be effective December 6, 2012, 37 TexReg 9515

Texas Administrative Code

TITLE 30	ENVIRONMENTAL QUALITY
PART 1	TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
CHAPTER 288	WATER CONSERVATION PLANS, DROUGHT CONTINGENCY PLANS, GUIDELINES AND REQUIREMENTS
SUBCHAPTER A	WATER CONSERVATION PLANS
RULE §288.2	**Water Conservation Plans for Municipal Uses by Public Water Suppliers**

(a) A water conservation plan for municipal water use by public water suppliers must provide information in response to the following. If the plan does not provide information for each requirement, the public water supplier shall include in the plan an explanation of why the requirement is not applicable.

(1) Minimum requirements. All water conservation plans for municipal uses by public water suppliers must include the following elements:

(A) a utility profile in accordance with the Texas Water Use Methodology, including, but not limited to, information regarding population and customer data, water use data (including total gallons per capita per day (GPCD) and residential GPCD), water supply system data, and wastewater system data;

(B) a record management system which allows for the classification of water sales and uses into the most detailed level of water use data currently available to it, including, if possible, the sectors listed in clauses (i) - (vi) of this subparagraph. Any new billing system purchased by a public water supplier must be capable of reporting detailed water use data as described in clauses (i) - (vi) of this subparagraph:

(i) residential;

(I) single family;

(II) multi-family;

(ii) commercial;

(iii) institutional;

(iv) industrial;

(v) agricultural; and,

(vi) wholesale.

(C) specific, quantified five-year and ten-year targets for water savings to include goals for water loss programs and goals for municipal use in total GPCD and residential GPCD. The goals established by a public water supplier under this subparagraph are not enforceable;

(D) metering device(s), within an accuracy of plus or minus 5.0% in order to

measure and account for the amount of water diverted from the source of supply;

(E) a program for universal metering of both customer and public uses of water, for meter testing and repair, and for periodic meter replacement;

(F) measures to determine and control water loss (for example, periodic visual inspections along distribution lines; annual or monthly audit of the water system to determine illegal connections; abandoned services; etc.);

(G) a program of continuing public education and information regarding water conservation;

(H) a water rate structure which is not "promotional," i.e., a rate structure which is cost-based and which does not encourage the excessive use of water;

(I) a reservoir systems operations plan, if applicable, providing for the coordinated operation of reservoirs owned by the applicant within a common watershed or river basin in order to optimize available water supplies; and

(J) a means of implementation and enforcement which shall be evidenced by:

(i) a copy of the ordinance, resolution, or tariff indicating official adoption of the water conservation plan by the water supplier; and

(ii) a description of the authority by which the water supplier will implement and enforce the conservation plan; and

(K) documentation of coordination with the regional water planning groups for the service area of the public water supplier in order to ensure consistency with the appropriate approved regional water plans.

(2) Additional content requirements. Water conservation plans for municipal uses by public drinking water suppliers serving a current population of 5,000 or more and/or a projected population of 5,000 or more within the next ten years subsequent to the effective date of the plan must include the following elements:

(A) a program of leak detection, repair, and water loss accounting for the water transmission, delivery, and distribution system;

(B) a requirement in every wholesale water supply contract entered into or renewed after official adoption of the plan (by either ordinance, resolution, or tariff), and including any contract extension, that each successive wholesale customer develop and implement a water conservation plan or water conservation measures using the applicable elements in this chapter. If the customer intends to resell the water, the contract between the initial supplier and customer must provide that the contract for the resale of the water must have water conservation requirements so that each successive customer in the resale of the water will be required to implement water conservation measures in accordance with the provisions of this chapter.

(3) Additional conservation strategies. Any combination of the following strategies shall be selected by the water supplier, in addition to the minimum requirements in paragraphs (1) and (2) of this subsection, if they are necessary to achieve the

stated water conservation goals of the plan. The commission may require that any of the following strategies be implemented by the water supplier if the commission determines that the strategy is necessary to achieve the goals of the water conservation plan:

(A) conservation-oriented water rates and water rate structures such as uniform or increasing block rate schedules, and/or seasonal rates, but not flat rate or decreasing block rates;

(B) adoption of ordinances, plumbing codes, and/or rules requiring water-conserving plumbing fixtures to be installed in new structures and existing structures undergoing substantial modification or addition;

(C) a program for the replacement or retrofit of water-conserving plumbing fixtures in existing structures;

(D) reuse and/or recycling of wastewater and/or graywater;

(E) a program for pressure control and/or reduction in the distribution system and/or for customer connections;

(F) a program and/or ordinance(s) for landscape water management;

(G) a method for monitoring the effectiveness and efficiency of the water conservation plan; and

(H) any other water conservation practice, method, or technique which the water supplier shows to be appropriate for achieving the stated goal or goals of the water conservation plan.

(b) A water conservation plan prepared in accordance with 31 TAC §363.15 (relating to Required Water Conservation Plan) of the Texas Water Development Board and substantially meeting the requirements of this section and other applicable commission rules may be submitted to meet application requirements in accordance with a memorandum of understanding between the commission and the Texas Water Development Board.

(c) A public water supplier for municipal use shall review and update its water conservation plan, as appropriate, based on an assessment of previous five-year and ten-year targets and any other new or updated information. The public water supplier for municipal use shall review and update the next revision of its water conservation plan every five years to coincide with the regional water planning group.

Source Note: The provisions of this §288.2 adopted to be effective May 3, 1993, 18 TexReg 2558; amended to be effective February 21, 1999, 24 TexReg 949; amended to be effective April 27, 2000, 25 TexReg 3544; amended to be effective October 7, 2004, 29 TexReg 9384; amended to be effective December 6, 2012, 37 TexReg 9515

Texas Administrative Code

TITLE 30	ENVIRONMENTAL QUALITY
PART 1	TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
CHAPTER 288	WATER CONSERVATION PLANS, DROUGHT CONTINGENCY PLANS, GUIDELINES AND REQUIREMENTS
SUBCHAPTER A	WATER CONSERVATION PLANS
RULE §288.5	**Water Conservation Plans for Wholesale Water Suppliers**

A water conservation plan for a wholesale water supplier must provide information in response to each of the following paragraphs. If the plan does not provide information for each requirement, the wholesale water supplier shall include in the plan an explanation of why the requirement is not applicable.

(1) Minimum requirements. All water conservation plans for wholesale water suppliers must include the following elements:

(A) a description of the wholesaler's service area, including population and customer data, water use data, water supply system data, and wastewater data;

(B) specific, quantified five-year and ten-year targets for water savings including, where appropriate, target goals for municipal use in gallons per capita per day for the wholesaler's service area, maximum acceptable water loss, and the basis for the development of these goals. The goals established by wholesale water suppliers under this subparagraph are not enforceable;

(C) a description as to which practice(s) and/or device(s) will be utilized to measure and account for the amount of water diverted from the source(s) of supply;

(D) a monitoring and record management program for determining water deliveries, sales, and losses;

(E) a program of metering and leak detection and repair for the wholesaler's water storage, delivery, and distribution system;

(F) a requirement in every water supply contract entered into or renewed after official adoption of the water conservation plan, and including any contract extension, that each successive wholesale customer develop and implement a water conservation plan or water conservation measures using the applicable elements of this chapter. If the customer intends to resell the water, then the contract between the initial supplier and customer must provide that the contract for the resale of the water must have water conservation requirements so that each successive customer in the resale of the water will be required to implement water conservation measures in accordance with applicable provisions of this chapter;

(G) a reservoir systems operations plan, if applicable, providing for the coordinated operation of reservoirs owned by the applicant within a common watershed or

river basin. The reservoir systems operations plans shall include optimization of water supplies as one of the significant goals of the plan;

(H) a means for implementation and enforcement, which shall be evidenced by a copy of the ordinance, rule, resolution, or tariff, indicating official adoption of the water conservation plan by the water supplier; and a description of the authority by which the water supplier will implement and enforce the conservation plan; and

(I) documentation of coordination with the regional water planning groups for the service area of the wholesale water supplier in order to ensure consistency with the appropriate approved regional water plans.

(2) Additional conservation strategies. Any combination of the following strategies shall be selected by the water wholesaler, in addition to the minimum requirements of paragraph (1) of this section, if they are necessary in order to achieve the stated water conservation goals of the plan. The commission may require by commission order that any of the following strategies be implemented by the water supplier if the commission determines that the strategies are necessary in order for the conservation plan to be achieved:

(A) conservation-oriented water rates and water rate structures such as uniform or increasing block rate schedules, and/or seasonal rates, but not flat rate or decreasing block rates;

(B) a program to assist agricultural customers in the development of conservation pollution prevention and abatement plans;

(C) a program for reuse and/or recycling of wastewater and/or graywater; and

(D) any other water conservation practice, method, or technique which the wholesaler shows to be appropriate for achieving the stated goal or goals of the water conservation plan.

(3) Review and update requirements. The wholesale water supplier shall review and update its water conservation plan, as appropriate, based on an assessment of previous five-year and ten-year targets and any other new or updated information. A wholesale water supplier shall review and update the next revision of its water conservation plan every five years to coincide with the regional water planning group.

Source Note: The provisions of this §288.5 adopted to be effective May 3, 1993, 18 TexReg 2558; amended to be effective February 21, 1999, 24 TexReg 949; amended to be effective April 27, 2000, 25 TexReg 3544; amended to be effective October 7, 2004, 29 TexReg 9384; amended to be effective December 6, 2012, 37 TexReg 9515

Texas Administrative Code

TITLE 30	ENVIRONMENTAL QUALITY
PART 1	TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
CHAPTER 288	WATER CONSERVATION PLANS, DROUGHT CONTINGENCY PLANS, GUIDELINES AND REQUIREMENTS
SUBCHAPTER B	DROUGHT CONTINGENCY PLANS
RULE §288.20	**Drought Contingency Plans for Municipal Uses by Public Water Suppliers**

(a) A drought contingency plan for a retail public water supplier, where applicable, must include the following minimum elements.

(1) Minimum requirements. Drought contingency plans must include the following minimum elements.

(A) Preparation of the plan shall include provisions to actively inform the public and affirmatively provide opportunity for public input. Such acts may include, but are not limited to, having a public meeting at a time and location convenient to the public and providing written notice to the public concerning the proposed plan and meeting.

(B) Provisions shall be made for a program of continuing public education and information regarding the drought contingency plan.

(C) The drought contingency plan must document coordination with the Regional Water Planning Groups for the service area of the retail public water supplier to insure consistency with the appropriate approved regional water plans.

(D) The drought contingency plan must include a description of the information to be monitored by the water supplier, and specific criteria for the initiation and termination of drought response stages, accompanied by an explanation of the rationale or basis for such triggering criteria.

(E) The drought contingency plan must include drought or emergency response stages providing for the implementation of measures in response to at least the following situations:

(i) reduction in available water supply up to a repeat of the drought of record;

(ii) water production or distribution system limitations;

(iii) supply source contamination; or

(iv) system outage due to the failure or damage of major water system components (e.g., pumps).

(F) The drought contingency plan must include specific, quantified targets for water use reductions to be achieved during periods of water shortage and drought. The entity preparing the plan shall establish the targets. The goals established by the entity under this subparagraph are not enforceable.

(G) The drought contingency plan must include the specific water supply or water demand management measures to be implemented during each stage of the plan including, but not limited to, the following:

(i) curtailment of non-essential water uses; and

(ii) utilization of alternative water sources and/or alternative delivery mechanisms with the prior approval of the executive director as appropriate (e.g., interconnection with another water system, temporary use of a non-municipal water supply, use of reclaimed water for non-potable purposes, etc.).

(H) The drought contingency plan must include the procedures to be followed for the initiation or termination of each drought response stage, including procedures for notification of the public.

(I) The drought contingency plan must include procedures for granting variances to the plan.

(J) The drought contingency plan must include procedures for the enforcement of any mandatory water use restrictions, including specification of penalties (e.g., fines, water rate surcharges, discontinuation of service) for violations of such restrictions.

(2) Privately-owned water utilities. Privately-owned water utilities shall prepare a drought contingency plan in accordance with this section and incorporate such plan into their tariff.

(3) Wholesale water customers. Any water supplier that receives all or a portion of its water supply from another water supplier shall consult with that supplier and shall include in the drought contingency plan appropriate provisions for responding to reductions in that water supply.

(b) A wholesale or retail water supplier shall notify the executive director within five business days of the implementation of any mandatory provisions of the drought contingency plan.

(c) The retail public water supplier shall review and update, as appropriate, the drought contingency plan, at least every five years, based on new or updated information, such as the adoption or revision of the regional water plan.

Source Note: The provisions of this §288.20 adopted to be effective February 21, 1999, 24 TexReg 949; amended to be effective April 27, 2000, 25 TexReg 3544; amended to be effective October 7, 2004, 29 TexReg 9384

Texas Administrative Code

TITLE 30	ENVIRONMENTAL QUALITY
PART 1	TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
CHAPTER 288	WATER CONSERVATION PLANS, DROUGHT CONTINGENCY PLANS, GUIDELINES AND REQUIREMENTS
SUBCHAPTER B	DROUGHT CONTINGENCY PLANS
RULE §288.22	**Drought Contingency Plans for Wholesale Water Suppliers**

(a) A drought contingency plan for a wholesale water supplier must include the following minimum elements.

(1) Preparation of the plan shall include provisions to actively inform the public and to affirmatively provide opportunity for user input in the preparation of the plan and for informing wholesale customers about the plan. Such acts may include, but are not limited to, having a public meeting at a time and location convenient to the public and providing written notice to the public concerning the proposed plan and meeting.

(2) The drought contingency plan must document coordination with the regional water planning groups for the service area of the wholesale public water supplier to insure consistency with the appropriate approved regional water plans.

(3) The drought contingency plan must include a description of the information to be monitored by the water supplier and specific criteria for the initiation and termination of drought response stages, accompanied by an explanation of the rationale or basis for such triggering criteria.

(4) The drought contingency plan must include a minimum of three drought or emergency response stages providing for the implementation of measures in response to water supply conditions during a repeat of the drought-of-record.

(5) The drought contingency plan must include the procedures to be followed for the initiation or termination of drought response stages, including procedures for notification of wholesale customers regarding the initiation or termination of drought response stages.

(6) The drought contingency plan must include specific, quantified targets for water use reductions to be achieved during periods of water shortage and drought. The entity preparing the plan shall establish the targets. The goals established by the entity under this paragraph are not enforceable.

(7) The drought contingency plan must include the specific water supply or water demand management measures to be implemented during each stage of the plan including, but not limited to, the following:

(A) pro rata curtailment of water deliveries to or diversions by wholesale water customers as provided in Texas Water Code, §11.039; and

(B) utilization of alternative water sources with the prior approval of the executive director as appropriate (e.g., interconnection with another water system, temporary use of a non-municipal water supply, use of reclaimed water for non-potable purposes, etc.).

(8) The drought contingency plan must include a provision in every wholesale water contract entered into or renewed after adoption of the plan, including contract extensions, that in case of a shortage of water resulting from drought, the water to be distributed shall be divided in accordance with Texas Water Code, §11.039.

(9) The drought contingency plan must include procedures for granting variances to the plan.

(10) The drought contingency plan must include procedures for the enforcement of any mandatory water use restrictions including specification of penalties (e.g., liquidated damages, water rate surcharges, discontinuation of service) for violations of such restrictions.

(b) The wholesale public water supplier shall notify the executive director within five business days of the implementation of any mandatory provisions of the drought contingency plan.

(c) The wholesale public water supplier shall review and update, as appropriate, the drought contingency plan, at least every five years, based on new or updated information, such as adoption or revision of the regional water plan.

Source Note: The provisions of this §288.22 adopted to be effective February 21, 1999, 24 TexReg 949; amended to be effective April 27, 2000, 25 TexReg 3544; amended to be effective October 7, 2004, 29 TexReg 9384

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APPENDIX C

TARRANT REGIONAL WATER DISTRICT
WHOLESALE PUBLIC WATER SUPPLIER PROFILE
BASED ON TCEQ FORMAT

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Appendix C

Tarrant Regional Water District Wholesale Public Water Supplier Profile Based on TCEQ Format

Name of Entity: Tarrant Regional Water District

Address & Zip: 800 East Northside Drive

Telephone Number: (817) 335-2491 **Fax:** (817) 877-5137

Water Right No.(s): TCEQ Reg Entity #: RN102904463,
TCEQ Cust #: CN602719957

Form Completed by: Laura Blaylock

Title: Hydrologist

Persons responsible for implementing conservation program: Mark Olson Phone: (817) 335-2491
Dean Minchillo Phone: (817) 335-2491

Signature: Date: May 1, 2014

NOTE: If the plan does not provide information for each requirement, include an explanation of why the requirement is not applicable.

PROFILE

I. WHOLESALE SERVICE AREA POPULATION AND CUSTOMER DATA

A. *Population and Service Area Data, 1-3*

Service area size (in square miles): (Please attach copy of service area map)	5,891
Current Population of Service Area (2013)	1,817,900
Current Population Served For:	
a. Water	1,817,900
b. Wastewater	TRWD does not provide any wastewater treatment

4. Population served for previous five years

2009	1,796,405
2010	1,771,443
2011	1,781,735
2012	1,795,707
2013	1,817,900

5. Projected population for service area in following decades

Year	Population Projections of Existing Customers	Population Projections including Potential Future Customers
2020	2,231,578	2,240,483
2030	2,603,534	2,637,546
2040	3,021,266	3,068,046
2050	3,438,944	3,506,895
2060	3,889,311	3,992,417
2070	4,408,280	4,574,167

6. Source method for the calculation of current and projected population

Population projections from the 2016 Region C Water Plan were used as a reference point for service area population. The percentage of populations within each county that is served by TRWD is based on information provided by Region C Water Planning Group (RCWPG).

Region C estimates have consistently trended significantly higher than historical data. Comparing historical numbers with population projections in 2010 shows the extent of the errant population numbers produced by RCWPG. The difference between the projected and historical population in 2010 represents an overestimation of 43 percent. One reason for this discrepancy in population numbers is Region C includes the entire population of communities served by TRWD, even though the communities may have other water supply sources, i.e. groundwater, which are used to supplement demands.

Current population (2009-2013) is estimated from data obtained from the North Central Texas Council of Governments. In communities where supplemental water supply sources are used, TRWD only accounts for the percentage of the population it serves. For instance, in Grand Prairie where the water district supplies 3.8 percent of the municipal water supply, only that portion of the population is accounted for in its population estimates.

B. Customers Data

List or attach names of all TRWD customers, amount of each annual contract, and amount of the annual use for each for the previous year:

CUSTOMER	CONTRACTUAL AMOUNT	USAGE IN 2013 (acre-feet)
City of Fort Worth (all)	All Needs	202,174
City of Arlington	All Needs	60,620
Trinity River Authority, Tarrant County Water Supply Project (TRA TCWSP)	All Needs	34,311
City of Mansfield	All Needs	10,756
City of Bridgeport	1,700	1,212
City of Waxahachie	All Needs	3,280
City of Midlothian	6,720.9	242
City of Jacksboro	263	0
City of Runaway Bay	1,120	327
Walnut Creek Water Supply Corp.	All Needs	2,160
West Wise SUD	986	355
Wise County WSD	4,000	1,536
Hanson Aggregates	1,475	0
Texas Industries, Inc.	1,200	0
Brazos Electric (Duke Energy)	4,257	4,186
Wise Co. Power Co. (Tractebel)	4,600	2,592
Trinity Materials	Temp	0
Runaway Bay Golf	124	27
The Lodge	Temp	0
Marock	Temp	0
City of Azle	1,680	1,527
Hawks' Creek Golf Club	150	193
Community Water Supply	1,851	331
City of Springtown	1,344	340
City of River Oaks	All Needs	735
The Resort Golf Club	350	120
Shady Oaks Country Club	575	141

CUSTOMER	CONTRACTUAL AMOUNT	USAGE IN 2013 (acre-feet)
The Landing	Temp	0
Tarrant County MUD	(currently not taking)	
TU Electric (Eagle Mountain Plant)	open	0
Exelon (TU electric services, Handley SES)	2,184	528
Benbrook Water Authority	All Needs	3,069
City of Weatherford	5,892	5,833
Ridglea Country Club	475.58	318
Mira Vista Country Club	568	233
FW Country Day School	153.45	22
Whitestone Golf, Ltd	400	166
Monarch/TECON (Carolynn + SW water Service)	All Needs	538
East Cedar Creek Fresh Water Supply District	All Needs	1,254
City of Kemp	600	286
City of Mabank	All Needs	981
City of Malakoff	All Needs	120
City of Star Harbor	168	85
City of Trinidad	Currently Not Taking	0
West Cedar Creek MUD	All Needs	1,330
Long Cove Ranch Co.	Temp	8
Cedar Creek Country Club	125	87
Golf Driving Range	4.6	0
Bill Sisul	Temp	2
Pinnacle Club	125	41
Tri-Stream	150	5
Winkler Water Supply Corp.	560	69
City of Corsicana	All Needs	0
Calpine/Freestone	5,602	3,305
City of Fairfield	1,680	0

II. WATER USE DATA FOR SERVICE AREA

A. Water Delivery

Indicate if the water provided under wholesale contracts is treated or raw water and the annual amount the previous five years:

All water supplied by TRWD is raw water. Data includes water provided under municipal contracts.

Year	Treated Water	Raw Water (acre-feet)
2009	n/a	331,221
2010	n/a	346,774
2011	n/a	394,034
2012	n/a	359,952
2013	n/a	334,010
Totals:	n/a	1,765,991

B. Water Accounting Data

1. Total amount of water diverted at point of diversion(s) for previous five years (in acre-feet) for all water uses:

	2009	2010	2011	2012	2013
January	21,178	21,940	25,146	22,959	22,151
February	19,465	20,166	23,112	21,102	20,359
March	21,936	22,725	26,045	23,780	22,943
April	24,152	25,021	28,676	26,183	25,261
May	28,416	29,439	33,739	30,806	29,721
June	33,181	34,375	39,397	35,972	34,705
July	40,769	42,237	48,407	44,198	42,642

	2009	2010	2011	2012	2013
August	42,688	44,224	50,685	46,278	44,648
September	34,260	35,493	40,679	37,142	35,834
October	29,036	30,081	34,475	31,478	30,369
November	23,783	24,638	28,238	25,783	24,875
December	21,733	22,515	25,804	23,561	22,731
Annual Total	340,596	352,854	404,402	369,243	356,240

2. Wholesale population served and total amount of water diverted for municipal use (in acre-feet) since 1999:

Year	Total Population Served	Total Annual Diverted for Municipal Use (acre-feet)
1999	1,412,471	268,145
2000	1,440,342	275,730
2001	1,473,172	279,052
2002	1,505,912	282,373
2003	1,538,652	285,694
2004	1,603,408	304,637
2005	1,645,901	370,942
2006	1,688,395	390,037
2007	1,725,218	306,373
2008	1,761,051	363,773
2009	1,796,405	331,221
2010	1,771,443	346,744
2011	1,781,735	394,034
2012	1,795,707	359,952
2013	1,817,900	334,010

C. Projected Water Demands

If applicable, project and attach water supply demands for the next ten years using information such as population trends, historical water use, and economic growth in the service area over the next ten years and any additional water supply requirement from such growth.

Year	Total Population Projected	Total Demands Projected (acre-feet)
2014	1,871,933	356,558
2015	1,927,572	377,531
2016	1,984,865	399,738
2017	2,043,860	423,252
2018	2,104,609	448,148
2019	2,167,164	474,509
2020	2,231,578	502,420
2021	2,266,247	509,181
2022	2,301,454	516,033
2023	2,337,208	522,978

III. WATER SUPPLY SYSTEM DATA

A. Water Supply Sources

List all current water supply sources and the amounts authorized with each:

Source*	Amount Authorized (acre-feet)
Lake Bridgeport	15,000
Eagle Mountain Lake	159,600
Cedar Creek Reservoir	175,000
Richland-Chambers Reservoir	210,000
Lake Benbrook	6,833
Reuse – Richland-Chambers	63,000
Reuse – Cedar Creek	52,500
Total permitted supply:	681,933

*All sources for TRWD are surface water. The Cedar Creek reuse project represents a future water supply source.

Permitted water supply does not reflect the amount of water TRWD can safely deliver to its customers without adversely affecting the watersheds from which the supplies originate. The following list of sources depicts firm yield capacities of TRWD's reservoir system. Firm yield of a reservoir is typically defined as the maximum yield that could be delivered without failure during the historical drought of record.

Source	**Firm Yield (acre-feet)**
Lake Bridgeport and Eagle Mountain Lake	79,000
Cedar Creek Reservoir	175,000
Richland-Chambers Reservoir	210,000
Lake Benbrook	6,833
Reuse – Richland-Chambers	63,000
Total firm yield:	533,833

B. Treatement and Distribution System

TRWD does not operate water treatment and distribution systems.

IV. WASTEWATER SYSTEM DATA

TRWD is a regional wholesale public water supplier and provides its customers with untreated water. It does not provide wastewater treatment services.

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APPENDIX D

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TCEQ WATER CONSERVATION IMPLEMENTATION REPORTS

Texas Commission on Environmental Quality

Water Conservation Implementation Report

Public Water Supplier

This five year report must be completed by entities that are required to submit a water conservation plan to the TCEQ in accordance with Title 30 Texas Administrative Code, Chapter 288. Please complete this report and submit it to the TCEQ. If you need assistance in completing this form, please contact the Resource Protection Team in the Water Availability Division at (512) 239-4691.

CONTACT INFORMATION

Name of Entity: Tarrant Regional Water District

Public Water Supply Identification Number (PWS ID):TCEQ Reg Entity #: RN102904463,

CCN numbers: TCEQ Cust #: CN602719957

Water Right Permit numbers: Certificates of Adjudication Nos. 08-3808 (Lake Bridgeport), 08-3809 (Eagle Mountain Lake), 08-4796 (Cedar Creek Reservoir) and 08-5035 (Richland – Chambers Reservoir) as well as Permit 5157 (Lake Benbrook)

Wastewater ID numbers: N/A

Check all that apply:

- ☐ Retail Public Water Supplier
- ☒ Wholesale Public Water Supplier

Address: 800 East Northside Drive City: Fort Worth Zip Code: 76102

Email: mark.olson@trwd.com Telephone Number: 817-335-2410

Regional Water Planning Group: C Map

Groundwater Conservation District: Click here to enter text.Map

Form Completed By: Mar Olson Title: Conservation and Creative Manager

Signature: MLO Date: 5/9/2014

Contact information for the person or department responsible for implementing the water conservation plan:

Name: Mark Olson Phone: 817-335-2491 Email: mark.olson@trwd.com
Name: Dean Minchillo Phone: 817-335-2491 Email: dean.minchillo@trwd.com

Report Completed on Date: 5/11/2014

Reporting Period (**check only one**):
☐ Fiscal Period Begin:Click here to enter a date.Period End: Click here to enter a date.
☒ Calendar Period Begin: January 2009 Period End: December 2013

Please check all of the following that apply to your entity:

☒ A surface water right holder of 1,000 acre-feet/year or more for non-irrigation uses
☐ A surface water right holder of 10,000 acre-feet/year or more for irrigation uses

Important
If your entity meets the following description, please skip page 3 and go directly to page 4.

Your entity is a Wholesale Public Water Supplier that ONLY provides wholesale water services for public consumption. For example, you only provide wholesale water to other municipalities or water districts.

Water Use Accounting

Retail Water Sold: *All retail water sold for public use and human consumption.*

Helpful Hints: There are two options available for you to provide the requested information. Both options ask the same information; however, the level of detail and break down of information differs between the two options. Please select just one option that works best for your entity and fill in the fields as completely as possible.

Fields that are gray are entered by the user. Select fields that are white and press F9 to updated fields.

For the five-year reporting period, enter the gallons of **RETAIL water sold** in each major water use category. Use **only one** of the following options.

Option 1

Water Use Category*	**Gallons Sold**
Single Family Residential	
Multi-Family Residential	
TOTAL Residential Use[1]	0
Industrial	
Commercial	
Institutional	
TOTAL Retail Water Sold[2]	0

1. [SF Res +MF Res = Residential Use]
2. [Res +Ind +Com +Ins = Retail Water Sold]

Option 2

Water Use Category *	**Gallons Sold**
Residential Select all of the sectors that your account for as "Residential". ☐Single Family ☐ Multi-Family	
Commercial Please select all of the sectors that your account for as "Commercial". ☐ Commercial ☐ Multi-Family ☐ Industrial ☐ Institutional	
Industrial Please select all of the sectors that your account for as "Industrial". ☐Industrial ☐ Commercial ☐ Institutional	
Other Please select all of the sectors that your account for as "Other". ☐Commercial ☐Multi-Family ☐ Industrial ☐ Institutional	
TOTAL Retail Water Sold[1]	0.00

1. [Res +Com +Ind + Other = Retail Water Sold]

Wholesale Water Exported: *Wholesale water sold or transferred out of the distribution system.*

For the five year reporting period, enter the gallons of **WHOLESALE water exported** to each major water use category.

Water Use Category*	**Gallons of Exported Wholesale Water**
Municipal Customers	575,449,933,341
Agricultural Customers[2]	2,376,542,132
Industrial Customers[3]	16,309,057,612
Commercial Customers	
Institutional Customers	
TOTAL Wholesale Water Exported [1, 4]	**594,135,533,085**

1. [Mun +Agr +Ind +Com +Ins = Wholesale Water Exported]

2. Agricultural Use represents water provided to golf courses for landscape irrigation, and does not represent water provided to grow agricultural crops. Used an estimated ratio of 0.40 percent to determine amount entered as "agricultural water use", which was based on water demands in 2012 and 2013.

3. The difference between total wholesale water and (municipal + agricultural use) was assumed to be industrial.

4. Total wholesale water exported and water in the municipal water category were derived from known quantities.

System Data

Fields that are gray are entered by the user. Select fields that are white and hit F9 to updated fields.

	Total Gallons During the Five-Year Reporting Period
Water Produced: Volume produced from own sources	594,135,533,085
Wholesale Water Imported : Purchased wholesale water imported from other sources into the distribution system	0
Wholesale Water Exported: Wholesale water sold or transferred out of the distribution system (Insert Total Volume calculated on Page 4)	594,135,533,085
TOTAL System Input : Total water supplied to the infrastructure	594,135,533,085 [Produced + Imported ~~– Exported~~ = System Input] All water produced as a wholesale water supplier is "exported". The volume included here is based on guidance from TWDB Annual Water Conservation Report.
Other Consumption Authorized for Use but not Sold: - back flushing water - line flushing - storage tank cleaning - golf courses - fire department use - parks - municipal government offices	
TOTAL Authorized Water Use: All water that has been authorized for use or consumption.	0.00 [Retail Water Sold + Other Consumption = Total Authorized]
Apparent Losses – Water that has been consumed but not properly measured (Includes customer meter accuracy, systematic data discrepancy, un- authorized consumption such as theft)	
Real Losses – Physical losses from the distribution system prior to reaching the customer destination (Losses less than standard meter error. Mainly due to routine pipeline maintenance and repair.)	38,500,000
Unidentified Water Losses	0.00 [System Input- Total Authorized - Apparent Losses - Real Losses = Unidentified Water Losses]
TOTAL Water Loss (only two years of data available FY 2013 and FY 2014)	38,500,000 [Apparent + Real + Unidentified = Total Water Loss]

Targets and Goals

In the table below, please provide the **specific and quantified five and ten-year targets for water savings** listed in your water conservation plan.

Fields that are gray are entered by the user. Select fields that are white and hit F9 to update fields.

Date	Target for: Total Municipal GPCD	Target for: Water Loss (expressed in GPCD)	Target for: Water Loss Percentage (expressed in Percentage)
Five-year target date: 12/31/2013	175	8.75	< 5 %
Ten-year target date: 12/31/2018	166	8.30	< 5 %

Are targets in the water conservation plan being met? Yes ☒ No ☐

If these targets are not being met, provide an explanation as to why, including any progress on these targets: Click here to enter text.

Gallons per Capita per Day (GPCD) and Water Loss

Compare your current gpcd and water loss to the above targets and goals set in your previous water conservation plan.

Total System Input in Gallons	Permanent Population, 2013	Current Total GPCD
594,135,533,085 [Produced + Imported – ~~Exported~~ = System Input]	1,817,900	179.1 [(System Input ÷ Permanent Population) /5/ 365]

Permanent Population is the total permanent population of the service area. This includes single family, multi-family, and group quarter populations. (What are group quarter populations?)

Total Municipal Use	Permanent Population	Municipal GPCD
575,449,933,341	1,817,900	173.5 [(Municipal Use ÷ Residential Population) / 5/ 365]

Residential Population is the total residential population of the service area including single & multi-family population. (You do realize that population increases over time? Population in Year 1 is less than population in Year 5)

Wholesale population served and total amount of water diverted for municipal use (in acre-feet) from utility profile included in the 2014 TRWD Water Conservation and Drought Contingency Plan (Appendix C):

Year	**Total Population Served**	**Total Annual Diverted for Municipal Use (acre-feet)**	**Municipal GPCD**
2009	1,796,405	331,221	164.6
2010	1,771,443	346,744	174.8
2011	1,781,735	394,034	197.4
2012	1,795,707	359,952	179.0
2013	1,817,900	334,010	163.6
Municipal GPCD without credit for reuse. Rolling 5 year average:			175.9
Municipal GPCD with credit for reuse. Rolling 5-year average:[1]			174.7

[1] In 2013, TRWD recycled 12,675 acre-feet at its Richland-Chambers Wetlands Reuse Project. Taking credit for reuse in calculating municipal gpcd reduces the amount diverted for municipal use to 321,335 acre-feet.

Total Water Loss (FY 2013 and FY 2014 data)	**Total System Input in Gallons (2012 and 2013 total water use)**	**Permanent Population**	**Water Loss calculated in GPCD [1] Percent [2]**	
38500000 [Apparent + Real + Unidentified = Total Water Loss]	236,399,361,033 [Water Produced + Wholesale Imported - Wholesale Exported]	1,817,900	0.03 gpcd	0.02 %

1. [Total Water Loss ÷ Permanent Population] / 2/ 365 = Water Loss GPCD]
2. [Total Water Loss ÷ Total System Input] x 100 = Water Loss Percentage]
3. Based on two years of water loss data. Used 2012 and 2013 total system input, 369,243 and 356,240 acre-feet respectively.

Water Conservation Programs and Activities

As you complete this section, please review your water conservation plan to see if you are making progress towards meeting your stated goals.

Fields that are gray are entered by the user. Select fields that are white and hit F9 to updated fields

1. Water Conservation Plan

What year did your entity adopt, or revise, their most recent water conservation plan: 2009

Does the plan incorporate Best Management Practices? Yes ☒ No ☐

2. Water Conservation Programs

For the reporting period, please select the types of activities and programs that have been actively administered, and estimate the expense and savings that incurred in implementing the conservation activities and programs for the past five years. Leave the field blank if unknown:

Program or Activity	Estimated Expenses	Estimated Gallons Saved
Conservation Analysis & Planning		
☒ Conservation Staff and Department Director	$1,440,000	
☐ Water Survey for Single-Family and Multi-Family Customers		
☒ Strategic Water Conservation Plan and additional modeling services	$330,000	
Financial		
☐ Wholesale Agency Assistance Programs		
☐ Water Conservation Pricing/ Rate Structures		
System Operations		
☒ Water Loss Audits		
☒ Leak Detection		
☒ Universal Metering and Metering Repair		
Landscaping		
☒ Landscape Irrigation Conservation and Incentives	$150,000	
☐ Athletic Fields Conservation		
☒ Golf Course Conservation		
☐ Park Conservation		
☒ Conservation Demonstration Garden	$250,000	
Education & Public Awareness		
☒ School Education	$220,000	
☒ Public Information	$5,020,000	

☒ Regional Symposium for customer cities	$125,000	
☒ Promotional Items	$62,500	
Rebate, Retrofit, and Incentive Programs		
☐ Conservation Programs for ICI Accounts		
☐ Residential Clothes Washer Incentive Program		
☐ Water Wise Landscape Design and Conversion Programs		
☐ Showerhead, Aerator, and Toilet Flapper Retrofit		
☐ Residential Toilet Replacement Programs		
☐ Rainwater Harvesting Incentive Program		
☐ ICI Incentive Programs		
Conservation Technology		
☒ Recycling and Reuse Programs (Water or Wastewater Effluent)		
☐ Rainwater Harvesting and Condensate Reuse Programs		
Regulatory and Enforcement		
☐ Prohibition on Wasting Water		
TOTAL (Approximately, includes program costs and salaries for 2.5 FE, 2009-2013)	$7,600,500	87,807,394,821

3. Reuse (Water or Wastewater Effluent)

For the reporting period, please provide the following data regarding the types of direct and indirect reuse activities that were administered for the past five years:

Reuse Activity	Estimated Volume (in gallons)
On-site irrigation	
Plant wash down	
Chlorination/de-chlorination	
Industrial	
Landscape irrigation (parks, golf courses)	
Agricultural	
Other, please describe: Richland-Chambers Indirect Reuse Project (since October – December 2013)	4,130,161,425
Estimated Volume of Recycled or Reuse	4,130,161,425

4. Water Savings

For the five-year reporting period 2009-2013, estimate the total savings that resulted from your overall water conservation activities and programs? (See table and description for how savings were derived below).

Estimated Gallons Saved (Total from Conservation Programs Table)	**Estimated Gallons Recycled or Reused** (Total from Reuse Table)	**Total Volume of Water Saved** [1]	**Dollar Value of Water Saved** [2, 3]
87,807,394,821	4,130,161,425	91,937,556,246	$70,332,231

1. [Estimated Gallons Saved + Estimated Gallons Recycled or Reused = Total Volume Saved]
2. Estimate this value by taking into account water savings, the cost of treatment or purchase of your water, and any deferred capital costs due to conservation.
3. Savings was calculated taking the average cost of wholesale water over the time period indicated above, which ranged from approximately $0.63 to $0.87 per 1,000 gallons. Average cost was $0.765 per 1,000 gallons. Savings does not take into account deferred capital costs due to conservation.

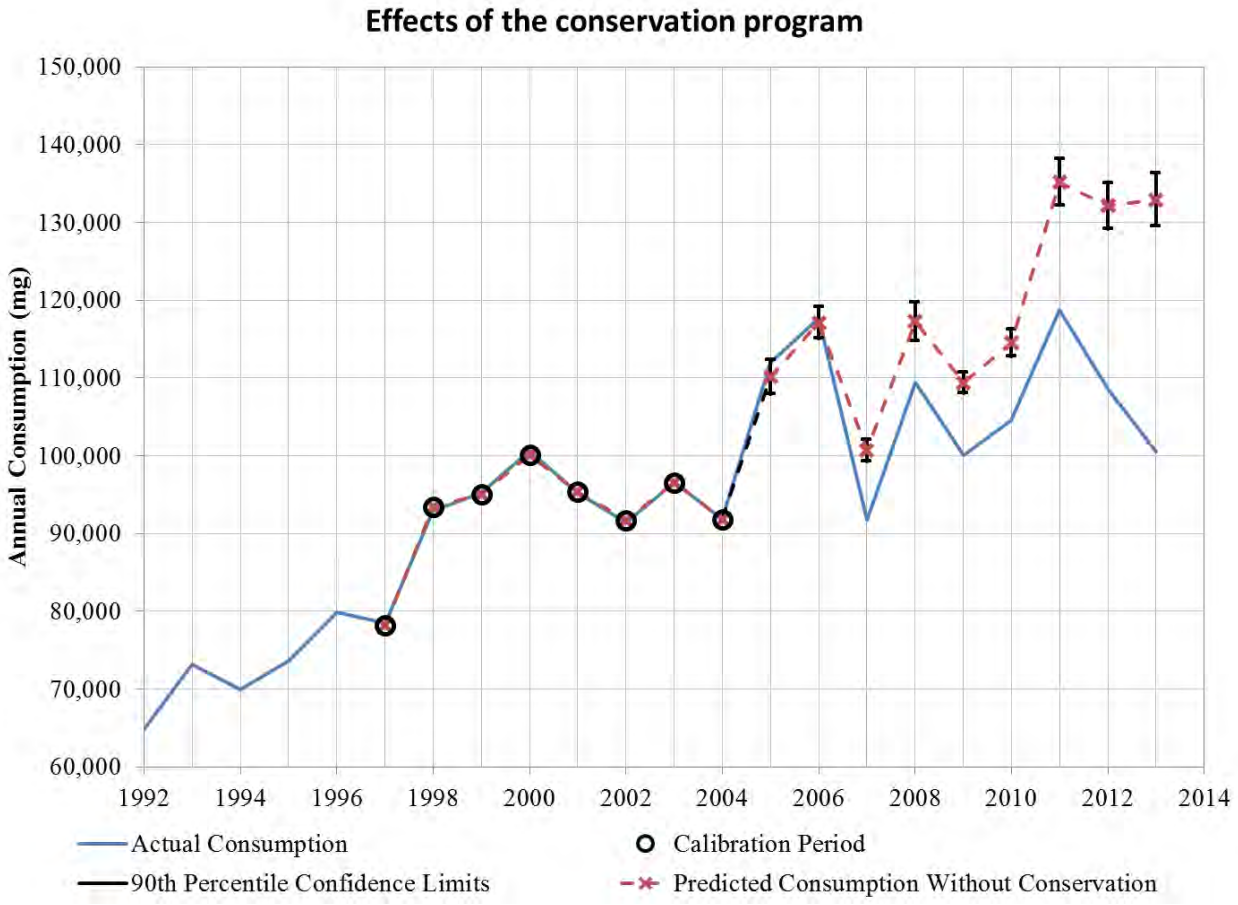
Estimated Annual Savings Due to Ongoing Water Conservation Efforts and Drought Contingency Measures, 2007-2013.

Savings based on an annual water demand model developed by Alan Plummer Associates, Inc., which was calibrated using pre-conservation program water demands, 1997-2004. Best fit parameters for TRWD demands include: average soil moisture, total June-Sept. rainfall, number of days with temperatures above 100^{o}F, and employment.

Year	Billion Gallons	Acre-Feet
2007	8.97	27,534
2008	7.95	24,395
2009	9.44	28,979
2010	9.65	29,612
2011	14.43	44,269
2012	21.86	67,070
2013	32.43	99,541
Total Savings	**104.72**	**321,400**

Note: Some savings in 2011 and 2012 can be attributed to the implementation of Stage 1 drought contingency measures, which were in effect from August 29, 2011 through May 3, 2012. The TRWD Water Conservation Strategic Plan (2013) estimates Stage 1 drought measures lowered demands by an additional 5.76 billion gallons during that timeframe. Drought restrictions in place since June 3, 2013, were also successful in reducing demands in 2013.

Savings for 2009-2013 amounted to 269,471 acre-feet or 87,807,394,821 billion gallons.



5. Conservation Pricing / Conservation Rate Structures

During the five-year reporting period, have your rates or rate structure changed? Yes ☒ No ☐

Please indicate the type of rate pricing structures that you use:

☒ Uniform rates	☐ Water Budget Based	☐ Surcharge - seasonal
☐ Flat rates	☐ Excess Use Rates	☐ Surcharge - drought
☐ Inclining/ Inverted	☐ Drought Demand rates	☐ Surcharge - usage
☐ Declining Block rates	☐ Tailored rates	
☐ Seasonal rates		

6. Public Awareness and Education Program

For the five-year reporting period, please check the appropriate boxes regarding any public awareness and educational activities that your entity has provided:

	Implemented	Number/Unit
Example: Brochures Distributed	☐	*10,000/year*
Example: Educational School Programs	☐	*50 students/month*
Brochures Distributed	☒	4,000/year on avg.
Messages Provided on Utility Bills	☐	N/A
Press Releases	☒	< 10
TV Public Service Announcements	☒	June – Sept each year
Radio Public Service Announcements	☒	June – Sept each year
Educational School Programs	☒	Support Major Rivers for about 5,000 middle school students in FWISD; Water Wise 5th grade curriculum reaches about 2,200 students annually
Displays, Exhibits, and Presentations	☒	15 – 25 annually
Community Events	☒	4 cleanups annually, Fort Worth Main Street Arts Festival since 2011, also support numerous events in customer cities
Social Media campaigns	☒	Ongoing since 2009
Facility Tours	☐	
Other :	☐	

7. Leak Detection

During the five-year reporting period, how many leaks were repaired in the system or at service connections: Click here to enter text.

Please check the appropriate boxes regarding the main cause of water loss in your system during the reporting period:

☐ Leaks and breaks
☐ Un-metered utility or city uses
☐ Master meter problems
☐ Customer meter problems
☐ Record and data problems
☐ Other: Click here to enter text.
☐ Other: Click here to enter text.

8. Universal Metering and Meter Repair

For the five-year reporting period, please provide the following information regarding meter repair:

	Total	**Total**	**Total**
Production Meters			
Meters larger than 1 ½"			
Meters 1 ½ or smaller			

Does your system have automated meter reading? Yes ☐ No ☒

9. Conservation Communication Effectiveness

In your opinion, how would you rank the effectiveness of your conservation activities in reaching the following types of customers for the past five years?

	Do not have activities or programs that target this type customer.	**Less Than Effective**	**Somewhat Effective**	**Highly Effective**
Residential Customers	☐	☐	☐	☒
Industrial Customers	☒	☐	☐	☐
Institutional Customers	☒	☐	☐	☐
Commercial Customers	☒	☐	☐	☐
Agricultural Customers	☐	☐	☒	☐

10. Drought Contingency and Emergency Water Demand Management

During the five-year reporting period, did you implement your Drought Contingency Plan?

Yes ☒ No ☐

If yes, indicate the number of days that your water use restrictions were in effect: 1) August 29, 2011 – May 4, 2012: 249 days in Stage 1 Drought; 2) June 3, 2013 – May 1, 2014: 333 days and counting in Stage 1 Drought

If yes, please check all the appropriate reasons for your drought contingency efforts going into effect.

☒ Water Supply Shortage	☐ Equipment Failure
☐ High Seasonal Demand	☐ Impaired Infrastructure
☐ Capacity Issues	☐ Other:

If you have any questions on how to fill out this form or about the Water Conservation program, please contact us at 512/239-4691.

Individuals are entitled to request and review their personal information that the agency gathers on its forms. They may also have any errors in their information corrected. To review such information, contact us at 512-239-3282.

Texas Commission on Environmental Quality

Water Conservation Implementation Report

This report must be completed by entities that are required to submit a water conservation plan to the TCEQ in accordance with Title 30 Texas Administrative Code, Chapter 288. Please complete this report and submit it to the TCEQ. If you need assistance in completing this form, please contact the Resource Protection Team in the Water Supply Division at (512) 239-4691.

Name:	Tarrant Regional Water District	
Address:	800 E. Northside Drive	
Telephone Number:	(817) 335-2491	**Fax:** (817) 877-5137
Form Completed By:	Mark Olson	**Title:** Water Conservation Coordinator
Signature:		**Date:** April 29, 2009

I. WATER USES

Indicate the type(s) of water uses (example: municipal, industrial, or agricultural).

_Municipal_____ Use

_Irrigation_____ Use

II. WATER CONSERVATION MEASURES IMPLEMENTED

Provide the water conservation measures and the dates the measures were implemented.

Public Outreach Campaign

Since spring 2007, TRWD has partnered with Dallas Water Utilities (DWU) to spread a uniform water conservation message across the Metroplex. The awareness campaign – "Save water. Nothing can replace it" – uses radio and television spots, newspaper ads, billboards, and other forms of communication to encourage people to use water responsibly. The cooperative spirit between DWU and TRWD is an excellent example of how agencies can unite to achieve a common goal. Together both agencies will spend $1.7 million for the 2009 campaign.

Brochures and Conservation Literature

TRWD developed an award-winning water conservation brochure in fall 2008. It contains water saving tips for both indoor and outdoor settings. The brochure was made available to customer cities for distribution at public events, libraries, municipal offices, garden centers, and home improvement stores. Additional printed materials will be developed as the Water District's conservation program matures and the need arises.

School Education Programs

Since 2003, TRWD has provided the "Learning to Be Water Wise" curriculum to the Fort Worth and Arlington Independent School Districts at no cost. In 2007, the city of North Richland Hills partnered with TRWD to provide the program in the Birdville ISD. The "Learning to Be Water Wise" curriculum includes student kits and activities to educate 5th grade students on the importance of water and the need for water conservation in their homes and communities. The kits contain water saving devices, which the students are encouraged to install in their own residences.

From 2004 to 2008, the Water District was a sponsor of a regional Newspapers in Education program about water. More than 1,000 area teachers signed up to receive a free supplement entitled, "Water: From Here to Eternity and Back Again." It was customized to include topics that specifically related to water issues in North Central Texas.

In 2005, TRWD began offering the "Major Rivers" curriculum to area school districts at no cost. The Arlington ISD was the first to adopt the program; the Fort Worth ISD began using it in 2007. "Major Rivers" is a curriculum designed to teach 4th grade students about Texas water resources, how water is treated and delivered to homes and schools, how to care for water resources, and how to use them wisely. A classroom package includes a teacher's guide with full color overhead transparencies, an introductory video, and full color student workbooks and home information leaflets. The Water District ordered teacher kits and replacement packages containing more than 9,000 student activity workbooks for the upcoming school year (2009-10).

Since 2005, the Water District has supported the distribution of book covers with a water conservation message to middle schools in Azle, Eagle-Mountain-Saginaw, Decatur, and Birdville Independent School Districts at no cost.

TRWD completed an interactive multi-media module in 2007 to educate students about its wetlands water reuse project. The product can be accessed online at www.trwd.com. The module blends short videos, panoramic photos and a game to teach school age children about wetland ecosystems and the environmental benefits of the water recycling project.

In 2008, the Water District created a student activitiy workbook to complement the information featured in the online wetland media module. The workbook was provided to 6th graders at All Saints Episcopal School in Fort Worth. Plans are in

the works to expand distribution to more students in the Water District's service area.

Water Efficient Landscaping

In response to drought conditions in 2005 and 2006, TRWD began encouraging its primary customers to implement 10 a.m. to 6 p.m. outdoor watering restrictions. Arlington, Fort Worth, Mansfield and most of the Water District's indirect customers in Tarrant County now have year-round ten to six outdoor watering restrictions in place.

TRWD was one of the original funding partners of the award-winning Texas SmartScape CD-ROM (originally released in May 2001). The Water District provided funding for the conversion of Texas SmartScape into an interactive Web site and for regional distribution of the CD version. Texas SmartScape is an educational tool designed to assist citizens with the design and development of landscaping using Texas native and drought tolerant plants.

In a partnership with the City of Fort Worth, TRWD helped fund the creation of a water conservation demonstration garden. The garden located at the Fort Worth Botanic Gardens was completed in May 2005. It is designed to show area residents the benefits, both environmental and aesthetic, of using native and adapted drought tolerant plants in their own residential setting. Information signs emphasizing the responsible use of our water resources are being developed.

Through a grant provided by the Texas Water Development Board, TRWD partnered with the city of Arlington in 2008 to develop another water conservation demonstration garden at the Southwest Branch Library. As a condition for grant funding, TRWD and the city coordinated workshops directed towards landscape professionals, builders, and developers on ways to design and install water efficient landscapes. Several more public workshops on waterwise landscaping were conducted spring 2009.

Internet

Beginning in 2007, TRWD began producing an online water conservation newsletter, available at its Web site (www.trwd.com). The "Supply Side" newsletter includes information about local water resources, trends in water use, and indoor and outdoor water saving suggestions.

To go along with its 2009 save water public awareness campaign, the Water District is revamping the www.savetarrantwater.com Web site. This site offers another channel to disseminate water conservation information. Ideally it will be a place to:

- Spotlight community conservation news and programs.
- Promote local events and public workshops.
- Feature stories and updates about water resources, water reuse, and conservation.

- Dig deeper into the principles of waterwise landscaping.
- Provide more in-depth and practical advice on how to save water.
- Discuss water efficient products and technology.

Community Group Presentations

TRWD has prepared and presented programs to area cities, civic organizations and other groups concerning the need for water conservation and strategies that can be implemented on an individual and corporate level. Presentations have been made to Rotary Clubs, Lions Clubs, Garden Clubs, Tarrant County Master Gardeners, Chambers of Commerce, mayors, city councils, city staff, etc.

Special Events

TRWD participates in several special events providing opportunities distribute water conservation information to the public:

The Water District sponsors a 2000-ft^2 landscape demonstration garden at Mayfest, a four-day outdoor community festival in Fort Worth. The event gives visitors an opportunity to see firsthand the beauty and water saving benefits of a Texas SmartScape. Master Gardeners of the Tarrant County Extension Office are on hand to educate the public about climate-appropriate landscaping. TRWD's participation as an exhibitor at Mayfest began in 2001.

The Water District also sponsors four lake and river cleanups annually – two in the spring and two in the fall. These special events provide excellent opportunities to emphasize the importance of protecting and conserving water resources. On average, a total of more than 2,000 volunteers join TRWD each year to clean the watersheds of Eagle Mountain Lake, Lake Bridgeport, the Trinity River, and Cedar Creek Reservoir. The first cleanup effort – the Trinity River Trash Bash – was started in 1992.

Indirect Water Reuse

TRWD is taking a lead role in water reuse by recycling return flows in the Trinity River. Return flows are a renewable resource; they are made up of water discharged by wastewater treatment plants in Fort Worth-Dallas area. A large portion of those flows originate from reservoirs managed by the Water District.

The first of TRWD's two planned indirect reuse projects began operations in spring 2009. The George Shannon Wetlands Water Recycling Facility is located adjacent to Richland-Chambers Reservoir. Over the next five years, the Water District plans to recycle enough water from the Trinity River to make up approximately two percent of its raw water supplies. That adds up to about 10 million gallons per day (MGD) eight months of the year.

Water Conservation Workshops

In 2007, the Water District held a water conservation symposium for its customer cities. The program was designed to show customers strategies that they could use

to save water, save money, and reduce demands. Speakers from across the nation were invited to share their experience and expertise. Discussions centered on key elements of successful water conservation programs. The symposium is now an annual event and jointly coordinated by the region's three major water providers – TRWD, North Texas Municipal Water District, and the city of Dallas.

In addition to the symposium, the Water District joined other North Texas water suppliers, and the Dallas and Fort Worth Chambers of Commerce to coordinate a Legislative Summit in October 2008 for state and local lawmakers. The event, which focused on water supply and conservation issues impacting North Texas, was repeated in December for water utility managers and their staff.

In summer 2008, TRWD held its first Water Conservation Coordinator Committee meeting. The meetings are held quarterly and offer representatives from many of the larger Tarrant County communities an opportunity to share water saving ideas and strategies. This is an effort by the Water District to regionalize approaches to water conservation.

Model Water Conservation and Drought Contingency Plans

Based on input from its primary customers, TRWD developed a model drought contingency plan for its direct and indirect customers in 2007. A model water conservation plan is in the process of being finalized.

III. TARGETS

A. Provide the **specific and quantified five and ten-year targets** as listed in water conservation plan for previous planning period. The numbers represent total gallons per person per day (total gpcd)

5-Year Specific/Quantified Target: 177
Date to achieve target: 2009

10-Year Specific/Quantified Target: 169
Date to achieve target: 2014

B. State if these targets in the water conservation plan are being met.

No. Using a five year rolling average, these goals have not been met. See below for an explanation.

C. List the **actual amount of water saved.**

The actual amount of water saved is difficult to quantify. However, the Water District has observed a decline in anticipated water demands of approximately 10 billion gallons annually since the implementation of 10 a.m. to 6 p.m. outdoor watering restrictions among many of its direct and indirect customers beginning in 2006.

An indirect reuse project at Richland-Chambers Reservoir, which began operations in spring 2009, will lead to additional water savings in the future. The Water District plans to recycle return flows in the Trinity River to supplement its water deliveries by approximately two percent. On average, the facility will recycle about 10 MGD during eight months of the year.

D. If the targets are not being met, provide an explanation as to why, including any progress on the targets.

As stated above, using a five year rolling average, we did not meet our target of 177 total gallons per capita per day in 2009. There are two primary reasons the goals were not achieved: (1) they were based on a single year of water use and (2) drought conditions in 2005 and 2006.

The targets listed in the Water District's 2005 Water Conservation and Drought Contingency Plan were based on a water use for a single year – 2004. The goals were essentially a snapshot of water use during a wet year, when water demands were lower than normal due excess rainfall. They were not representative of overall water use trends within the TRWD service area.

In addition, drought conditions in 2005 and 2006 led to an increase in per capita water use within the TRWD service area. In 2005, North Texas experienced the fifth driest year on record. Only 18.57 inches of rain was recorded at DFW International Airport. That's about half of what we normally receive. In 2006, more than 40 percent of the rain we received fell September through December. The rains did not provide much relief until after the peak in summertime irrigation.

However, when it comes to water use among the Water District's primary customers and their successive customers, we are seeing some positive trends and an overall decline in water use on a per capita basis. TRWD's primary customers are located in Tarrant County and include the cities of Arlington, Fort Worth, Mansfield and the Trinity River Authority (Bedford, Colleyville, Euless, Grapevine, and North Richland Hills). They are the recipients of approximately 90 to 92 percent of all TRWD water deliveries. A list of all direct and indirect customers is included in Section 3 of this Water Conservation and Drought Contingency Plan.

The declines in per capita demands can be observed when comparing total water use in years with similar climatic conditions. The discussion that follows is based on information in Table 4.1.

Looking at water use comparisons between two wet years (2004 and 2007), TRWD water deliveries remained essentially unchanged at 282,700 and 284,343 acre-feet, respectively. However, the estimated population of our primary customers increased by approximately 113,000 or 7.6 percent. The result was more people using about the same amount of water, which can be observed by the drop in demands – from 170 to 158.9 total gpcd in 2004 and 2007, respectively. The average reduction of 11.1 gallons per person per day represents a decline in consumer demands of about 6.5 percent.

The decline is not so dramatic when comparing two moderately dry years (2003 and 2008). Per capita water use decreased slightly between those years from 186.0 to 184.6 total gpcd in 2003 and 2008, respectively; population increased by approximately 12.8 percent, while the amount of water supplied to our primary customers increased 12.0 percent. It doesn't look like much of a change on the surface, but the real story lies in the difference between the amounts of precipitation received during the summer (when water use is at its peak). In 2003, North Texas received more than twice the rainfall (June through September) than it did in 2008.

A better comparison might be to look at water use between 2006 and 2008. Precipitation amounts in each of those years were very similar, especially during the summer months with an observed difference of only 0.07 inches. Drought conditions were also prevalent in each year. Despite the similar climatic conditions and a 4.3 percent increase in population, water consumption was much lower in 2008. Total gpcd declined from 206.8 to 184.6 in 2006 and 2008, respectively – a decrease of nearly 11 percent.

It's hard to pinpoint the exact reasons for the reductions we are observing in water consumption on a per capita basis. However, we are confident that some of the lower demands are due to the water conservation strategies being put into effect. We feel like the 10 to 6 outdoor watering restrictions are making a difference. Regionalizing our conservation efforts is also important. That's why the Water District is striving to build partnerships with its customers and other water providers throughout North Texas. Teaming up with the city of Dallas to share costs and encourage responsible water use through the "Save Water – Nothing can replace it" outreach campaign is a great example.

Based on our observations, conservation is gaining traction in North Texas. Water use on a per capita basis is decreasing and the Water District is taking steps to increase the likelihood that the trend will continue.

If you have any questions on how to fill out this form or about the Water Conservation program, please contact us at 512/239-4691.

Individuals are entitled to request and review their personal information that the agency gathers on its forms. They may also have any errors in their information corrected. To review such information, contact us at 512-239-3282.

APPENDIX E

ANNUAL WATER CONSERVATION REPORTS SUBMITTED TO TEXAS WATER DEVELOPMENT BOARD (TWDB)

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APPENDIX E
Annual Water Conservation Reports Submitted to TWDB
TRWD Water Use Information (2013)

Water Conservation Annual Report – Wholesale Water Suppliers
TWDB Form No.1969
Revised on 1/10/13

Water Conservation Plan Annual Report
Wholesale Water Supplier

CONTACT INFORMATION

Name of Entity: Tarrant Regional Water District

Public Water Supply Identification Number (PWS ID): _____

CCN Number: TCEQ Reg Entity #: RN102904463, TCEQ Cust #: CN602719957

Water Rights ID Number: Certificates of Adjudication Nos. 08-3808 (Lake Bridgeport),

Wastewater ID Number: _____

Check all that apply:

- ☐ Retail Water Supplier
- ☑ Wholesale Water Supplier
- ☐ Wastewater Treatment Utility

Address: 800 E. Northside Drive City: Fort Worth Zip Code: 76102

Email: mark.olson@trwd.com Telephone Number: 817-335-2491

Regional Water Planning Group: C Map

Groundwater Conservation District: _____ Map

Form Completed By: Mark Olson & Laura Blaylock Title: Conservation and Cre

Date: 04-24-2014

Reporting Period (**check only one**):

- ○ Fiscal Period Begin(mm/yyyy) _____ Period End(mm/yyyy) _____
- ◉ Calendar Period Begin(mm/yyyy) 01/2013 Period End(mm/yyyy) 12/2013

Check all that apply:

- ☐ Received financial assistance of $500,000 or more from TWDB
- ☐ Have 3,300 or more retail connections
- ☑ Have a surface water right with TCEQ

Page **1** of **5**

Water Conservation Annual Report ~ Wholesale Water Suppliers
TWDB Form No.1969
Revised on 1/10/13

SYSTEM DATA

1. For this reporting period, provide the **total volume of wholesale water exported** (transferred or sold): 116081160240 gallons

2. For this reporting period, does your billing/accounting system have the capability to classify customers into the Wholesale Customer Categories?
   (●) Yes ( ) No

3. For this reporting period, select the category(s) used to calculate wholesale customer water usage:
   - [x] Municipal
   - [x] Industrial
   - [ ] Commercial
   - [x] Institutional
   - [ ] Agricultural

Wholesale Customer Categories*
- Municipal
- Industrial
- Commercial
- Institutional
- Agricultural

**Recommended Customer Categories for classifying customer water use. For definitions, refer to Guidance and Methodology on Water Conservation and Water Use.*

4. For this reporting year, enter the gallons of **WHOLESALE water exported** (transferred or sold). Enter zero if a Customer Category does not apply.

Wholesale Customer Category	Gallons Exported (transferred or sold)	Number of Customers
Municipal	108837492510	28
Industrial	6801162072	5
Commercial	0	
Institutional	0	
Agricultural	442,505,658	15
~~Total~~	116081160240	48

Water Conservation Annual Report – Wholesale Water Suppliers
TWDB Form No.1969
Revised on 1/10/13

Water Use Accounting

	Total Gallons During the Reporting Period
Water Produced: Water from permitted sources such as rivers, lakes, streams, and wells.	116081160240
Wholesale Water Imported: Purchased wholesale water transferred into the system.	0
System Input: Total water supplied to system and available for use.	116081160240 Produced + Imported = System Input
Wholesale Water Exported: Wholesale water sold or transferred out of the system.	116081160240
Gallons Per Day:	318,030,576 Wholesale Water Exported ÷ 365 = Gallons Per Day
Population: Estimated total population for municipal customers.	1,817,900
	164 Municipal Exported ÷ Municipal Population ÷ 365 = Municipal Gallons Per Capita Per Day

Provide the **specific and quantified five and ten-year targets** as listed in your most current Water Conservation Plan.

	Date to Achieve Target	Specified and Quantified Targets
Five-year target	2013	Rolling 5-year avg. = 175
Ten-year target	2018	Rolling 5-year avg. = 166

Page **3** of **5**

Water Conservation Annual Report ~ Wholesale Water Suppliers
TWDB Form No.1969
Revised on 1/10/13

Water Conservation Programs and Activities

1. Water Conservation Plan

What year did your entity adopt or revise their most recent Water Conservation Plan? 2009

Does The Plan incorporate Best Management Practices? (●) Yes ( ) No

2. Water Conservation Programs

Has your entity implemented any type of water conservation activity or program?
(●) Yes ( ) No

If yes, select the type(s) of Best Management Practices or water conservation strategies implemented during this reporting period.

Wholesale Supplier Activities and Practices	
☐	Agricultural Conservation Programs
☑	Conservation Analysis & Planning
☐	Conservation Rate Structures
☐	Conservation Technology
☑	Education & Public Awareness
☐	Industrial Conservation Programs
☑	Leak Detection/ Water Loss Program
☐	Rebate, Retrofit, and Incentive Programs
☐	Regulatory & Enforcement
☑	System Operations
☑	Water Efficient Landscape Programs
☑	Water Use Audits

Other activities, list or describe.

Notes:
1) Launched joint public outreach media campaign with City of Dallas beginning in 2009.

3. Recycle/Reuse (Water or Wastewater Effluent)

For this reporting period, provide direct and indirect reuse activities.

Reuse Activity	Estimated Volume (in gallons)
On-site irrigation	
Plant wash down	
Chlorination/de-chlorination	
Industrial	
Landscape irrigation (parks, golf courses)	
Agricultural	
Other, please describe: Richland-Chambers Wetlands Indirect	4,130,161,425
Estimated Volume of Reuse	4,130,161,425

Water Conservation Annual Report – Wholesale Water Suppliers
TWDB Form No.1969
Revised on 1/10/13

4. Water Savings

For this reporting period, estimate the savings that resulted from water conservation activities and programs.

Estimated Gallons Saved/Conserved	Estimated Gallons Recycled/Reused	Total Volume of Water Saved[1]	Dollar Value of Water Saved[2]
32435000000	4,130,161,425	36565161425	$ 31,994,151

1. Estimated Gallons Saved + Estimated Gallons Recycled/Reused = Total Volume Saved
2. Estimate this value by taking into account water savings, the cost of treatment or purchase of water, and deferred capital costs due to conservation.

5. Program Effectiveness

In your opinion, how would you rank the overall effectiveness of your conservation programs and activities?

Less Than Effective	Somewhat Effective	Highly Effective	Does Not Apply
○	○	◉	○

6. What might your entity do to improve the effectiveness of your water conservation program?

We've been under Stage 1 drought restrictions since June 3, 2013. Our average daily water use, due in large part to the restrictions, was nearly 30 mgd less than it was last year. The drought conditions combined with an increased awareness of the status of our water supplies is helping to lower demands. In addition, we are confident that our water conservation awareness and education program is making a difference. Add to that, the programs implemented by our customers, such as tiered water rates, water loss and leak

7. Select the areas for which you would like to receive technical assistance:

- ☐ Agricultural Best Management Practices
- ☐ Wholesale Best Management Practices
- ☐ Industrial Best Management Practices
- ☐ Drought Contingency Plans
- ☐ Landscape Efficient Systems
- ☐ Leak Detection and Equipment
- ☐ Educational Resources
- ☐ Water Conservation Plans
- ☐ Water IQ: Know Your Water
- ☐ Water Loss Audits
- ☐ Rainwater Harvesting Systems
- ☐ Recycling and Reuse

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TRWD Water Use Information (2012)

Water Conservation Annual Report – Wholesale Water Suppliers
TWDB Form No.1969
Revised on 1/10/13

Water Conservation Plan Annual Report
Wholesale Water Supplier

CONTACT INFORMATION

Name of Entity: Tarrant Regional Water District

Public Water Supply Identification Number (PWS ID): _____

CCN Number: TCEQ Reg Entity #: RN102904463, TCEQ Cust #: CN602719957

Water Rights ID Number: Certificates of Adjudication Nos. 08-3808 (Lake Bridgeport),

Wastewater ID Number: _____

Check all that apply:

- ☐ Retail Water Supplier
- ☑ Wholesale Water Supplier
- ☐ Wastewater Treatment Utility

Address: 800 E. Northside Drive City: Fort Worth Zip Code: TX

Email: mark.olson@trwd.com Telephone Number: 817-335-2491

Regional Water Planning Group: C Map

Groundwater Conservation District: _____ Map

Form Completed By: Mark Olson & Laura Blaylock Title: Conservation Manage

Date: 04-25-2013

Reporting Period (**check only one**):

- ○ Fiscal Period Begin(mm/yyyy) _____ Period End(mm/yyyy) _____
- ◉ Calendar Period Begin(mm/yyyy) 01/2012 Period End(mm/yyyy) 12/2012

Check all that apply:

- ☐ Received financial assistance of $500,000 or more from TWDB
- ☐ Have 3,300 or more retail connections
- ☑ Have a surface water right with TCEQ

Page **1** of **5**

Water Conservation Annual Report ~ Wholesale Water Suppliers
TWDB Form No.1969
Revised on 1/10/13

SYSTEM DATA

1. For this reporting period, provide the **total volume of wholesale water exported** (transferred or sold): 120,504,011,170 gallons

2. For this reporting period, does your billing/accounting system have the capability to classify customers into the Wholesale Customer Categories?
   (●) Yes ( ) No

3. For this reporting period, select the category(s) used to calculate wholesale customer water usage:
   - [x] Municipal
   - [x] Industrial
   - [ ] Commercial
   - [x] Institutional
   - [ ] Agricultural

Wholesale Customer Categories*
- Municipal
- Industrial
- Commercial
- Institutional
- Agricultural

**Recommended Customer Categories for classifying customer water use. For definitions, refer to Guidance and Methodology on Water Conservation and Water Use.*

4. For this reporting year, enter the gallons of **WHOLESALE water exported** (transferred or sold). Enter zero if a Customer Category does not apply.

Wholesale Customer Category	Gallons Exported (transferred or sold)	Number of Customers
Municipal	115,461,973,364	27
Industrial	4,476,300,880	7
Commercial	0	
Institutional	565,736,926	15
Agricultural	0	
~~Total~~	120,504,011,170	49

Water Conservation Annual Report – Wholesale Water Suppliers
TWDB Form No.1969
Revised on 1/10/13

Water Use Accounting

	Total Gallons During the Reporting Period
Water Produced: Water from permitted sources such as rivers, lakes, streams, and wells.	120,504,011,170
Wholesale Water Imported: Purchased wholesale water transferred into the system.	0
System Input: Total water supplied to system and available for use.	120,504,011,170 Produced + Imported = System Input
Wholesale Water Exported: Wholesale water sold or transferred out of the system.	120,504,011,170
Gallons Per Day:	330,147,976 Wholesale Water Exported ÷ 365 = Gallons Per Day
Population: Estimated total population for municipal customers.	1,795,613
	176 Municipal Exported ÷ Municipal Population ÷ 365 = Municipal Gallons Per Capita Per Day

Provide the **specific and quantified five and ten-year targets** as listed in your most current Water Conservation Plan.

	Date to Achieve Target	Specified and Quantified Targets
Five-year target	2013	Rolling 5-yr avg. = 175
Ten-year target	2018	Rolling 5-yr avg. = 166

Water Conservation Annual Report ~ Wholesale Water Suppliers
TWDB Form No.1969
Revised on 1/10/13

Water Conservation Programs and Activities

1. Water Conservation Plan

What year did your entity adopt or revise their most recent Water Conservation Plan? 2009

Does The Plan incorporate Best Management Practices? (●) Yes ( ) No

2. Water Conservation Programs

Has your entity implemented any type of water conservation activity or program?
(●) Yes ( ) No

If yes, select the type(s) of Best Management Practices or water conservation strategies implemented during this reporting period.

Wholesale Supplier Activities and Practices
☐ Agricultural Conservation Programs
☑ Conservation Analysis & Planning
☐ Conservation Rate Structures
☐ Conservation Technology
☑ Education & Public Awareness
☐ Industrial Conservation Programs
☑ Leak Detection/ Water Loss Program
☐ Rebate, Retrofit, and Incentive Programs
☐ Regulatory & Enforcement
☐ System Operations
☑ Water Efficient Landscape Programs
☑ Water Use Audits

Other activities, list or describe.

Notes:
1) Launched joint public outreach media campaign with City of Dallas beginning in 2009.

3. Recycle/Reuse (Water or Wastewater Effluent)

For this reporting period, provide direct and indirect reuse activities.

Reuse Activity	Estimated Volume (in gallons)
On-site irrigation	
Plant wash down	
Chlorination/de-chlorination	
Industrial	
Landscape irrigation (parks, golf courses)	
Agricultural	
Other, please describe:	
Estimated Volume of Reuse	0

Water Conservation Annual Report – Wholesale Water Suppliers
TWDB Form No.1969
Revised on 1/10/13

4. Water Savings

For this reporting period, estimate the savings that resulted from water conservation activities and programs.

Estimated Gallons Saved/Conserved	Estimated Gallons Recycled/Reused	Total Volume of Water Saved[1]	Dollar Value of Water Saved[2]
21,855,199,468	0	21,855,199,468	$ 17,800,000

1. Estimated Gallons Saved + Estimated Gallons Recycled/Reused = Total Volume Saved
2. Estimate this value by taking into account water savings, the cost of treatment or purchase of water, and deferred capital costs due to conservation.

5. Program Effectiveness

In your opinion, how would you rank the overall effectiveness of your conservation programs and activities?

Less Than Effective	Somewhat Effective	Highly Effective	Does Not Apply
○	○	◉	○

6. What might your entity do to improve the effectiveness of your water conservation program?

We are confident that our water conservation awareness and education program is effectively reaching customers and improving the efficiency of their water use. The programs implemented by our customers, such as tiered water rate structures and permanent daytime watering restrictions are also lowering overall demands. We will evaluate the options presented in our recently published strategic water conservation plan to increase water savings in the future. One option we are pursuing is the adoption of a

7. Select the areas for which you would like to receive technical assistance:

- ☐ Agricultural Best Management Practices
- ☐ Wholesale Best Management Practices
- ☐ Industrial Best Management Practices
- ☐ Drought Contingency Plans
- ☐ Landscape Efficient Systems
- ☐ Leak Detection and Equipment
- ☐ Educational Resources
- ☐ Water Conservation Plans
- ☐ Water IQ: Know Your Water
- ☐ Water Loss Audits
- ☐ Rainwater Harvesting Systems
- ☐ Recycling and Reuse

SUBMIT

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APPENDIX F

TRWD CUSTOMER WATER CONSERVATION REPORT

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APPENDIX F
Customer Water Conservation Report
Due May 1 of Every Year

Name of Entity: _____

Address & Zip: _____

Telephone Number: _____ **Fax:** _____

Form Completed By: _____

Title: _____

Signature: _____ **Date:** _____

Name and Phone Number of Person/Department responsible for implementing a water conservation program:

_____

NOTE: A downloadable and more user friendly version of this report can be found on the TCEQ web site at http://www.tceq.state.tx.us/permitting/water_rights/conserve.html/#forms.

UTILITY PROFILE

I. POPULATION CUSTOMER DATA

A. Population and Service Area Data

1. Attach a copy of your service area map.
2. Service area size (square miles): _____
3. Current population of service area: _____
4. Current population served by utility:

   a: water _____

   b: wastewater _____

5. Population served by water utility service area for the previous five years:

Year	Population
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

6. Projected population for in the following decades:

Year	Population
2020	_____
2030	_____
2040	_____
2050	_____
2060	_____

7. List specific source(s)/method(s) for the calculation of current and projected population:

B. Customers Data

Senate Bill 181 requires that uniform consistent methodologies for calculating water use and conservation be developed and available to retail water providers and certain other water use sectors as a guide for preparation of water use reports, water conservation plans, and reports on water conservation efforts. A water system must provide the most detailed level of customer and water use data available to it, however, any new billing system purchased must be capable of reporting data for each of the sectors listed below. http://www.tceq.texas.gov/assets/public/permitting/watersupply/water_rights/sb181_guidance.pdf

1. Current number of active connections by user type. Check whether multi-family service is counted as Residential ___ or Commercial ____ .

Treated water users	**Metered**	**Not-metered**	**Totals**
Residential:			
Single Family			
Multi-Family			
Commercial			
Industrial/mining			
Institutional			
Agriculture			
Other/Wholesale			

2. List the new number of new connections per year for most recent three years:

Year			
Treated water users	**Metered**	**Not-metered**	**Totals**
Residential:			
Single Family			
Multi-Family			
Commercial			
Industrial/mining			
Institutional			
Agriculture			
Other/Wholesale			

3. List annual water use for the five highest volume customers.

	Customer	**Use (1,000 gallons / year)**	**Treated / Raw Water**
(1)			
(2)			
(3)			
(4)			
(5)			

II. WATER USE DATA FOR SERVICE AREA

A. Water Accounting Data

1. Amount of water use for previous five years (in 1,000 gal.):

   Please indicate: Diverted Water _____

   Treated Water _____

Total Diverted and Treated Water Deliveries and Sales by Month					
Month	**Year**				
January					
February					
March					
April					
May					
June					
July					
August					
September					
October					
November					
December					
Total					

Describe how the above figures were determined (e.g., from a master meter located at the point of a diversion from the source or located at a point where raw water enters the treatment plant, or from water sales).

2. Amount of water (in 1,000 gallons) delivered (sold) as recorded by the following account types for the past five years.

Account Types	**Year**				
Residential					
Single Family					
Multi-Family					
Commercial					
Industrial/Mining					
Institutional					
Agricultural					
Other/Wholesale					

3. List previous records for water loss (the difference between water diverted or treated and water delivered or sold). The goal for percent of unaccounted for water is 12%.

Year	**Amount (gal.)**	**% of Total Water Diverted or Treated**
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

4. List previous five years records for water reuse. Reuse is the authorized use for one or more beneficial purposes of use of water that remains unconsumed after the water is used for the original purpose of use and before that water is either disposed of or discharged or otherwise allowed to flow into a watercourse, lake or other body of state-owned water.

Year	**Amount (gal.)**	**% of Total Water Diverted or Treated**
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

5. Municipal per capita water use (in gallons per day) for previous five years. Municipal per capita water use is the sum total of water diverted into a water supply system for residential, commercial, and public and institutional uses divided by total population served. GPCD includes water losses.

Year	**Population**	**Total Water Diverted (or Treated)(1,000 gal.)**	**Municipal Per Capita Use (GPCD)**
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

Source of Population data: _____

_____

B. Projected Water Demands

If applicable, attach or cite projected water supply demands for next ten years using information such as population trends, historical water use, and economic growth in the service area and any additional water supply requirement for such growth.

APPENDIX G

TRWD STRATEGIC WATER CONSERVATION PLAN EXECUTIVE SUMMARY

JANUARY 2013

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APPENDIX G
TRWD Strategic Water Conservation Plan Executive Summary (2013)

TRWD Strategic Water Conservation Plan

ES. Executive Summary

Over the next fifty years, total TRWD water demands are projected to double (Ref. 1). Proposed water management strategies for TRWD include water conservation, water reuse projects at Richland-Chambers Reservoir and Cedar Creek Reservoir, participating with other water suppliers to develop Marvin Nichols Reservoir, and participating with other water suppliers to obtain water from Toledo Bend Reservoir and from Oklahoma. The projected capital cost for these projects is $4.73 billion (Ref. 1).

To obtain water from Marvin Nichols Reservoir (to be located in the Sulphur River Basin) by 2030 and Toledo Bend Reservoir (located in the Sabine River Basin) by 2050, the TRWD and other project participants will have to apply for and obtain authorization to transfer water to the Trinity River Basin. Currently, interbasin transfer regulations require applicants to have "developed and implemented a water conservation plan that will result in the highest practicable levels of water conservation and efficiency achievable within the jurisdiction of the applicant" (Ref. 2).

From 2007 through 2011, ongoing water conservation efforts have helped TRWD to save approximately 42.4 billion gallons (130,250 acre-feet) of water, for an average savings of 23.2 million gallons per day (mgd). At the current per capita water demand, these water savings have stretched the existing water supply enough to meet the needs of an additional 132,200 people. This Strategic Water Conservation Plan (Strategic Plan) provides a road map to additional water savings and is an important step toward achieving the "highest practicable levels of water conservation and efficiency." Implementation of this Strategic Plan will extend the life of existing TRWD water supplies and reduce operating costs. Other potential benefits include delaying the need for new water supplies, deferring the associated capital costs, and minimizing associated environmental impacts. This document defines water conservation goals for the five-year planning period from 2013 through 2017 and recommends water conservation measures, budgets, and staffing levels to achieve these goals.[1]

ES.1. Strategic Plan Development Process (Section 1.1)

This document was developed through review of numerous water conservation programs, measures, data, and literature and through input from TRWD staff, TRWD wholesale customer cities, and water conservation staff from other cities.

Water use data from TRWD and its four primary customers (Fort Worth, Arlington, Mansfield, the Trinity River Authority Tarrant County Water Supply Project and their successive customers) were examined to identify strategic areas to target for additional water conservation opportunities. Numerous water conservation measures were evaluated using screening criteria, a benefit-cost analysis, and other means to determine their suitability for implementation during the five-year planning period. New water conservation goals were established, and recommended

[1] In the title of each section of the Executive Summary, the corresponding section in the main report is identified in parentheses.

measures were constructed into a framework plan and presented to TRWD and its customer cities for comment. Feedback was analyzed and used to develop the Strategic Plan.

ES.2. TRWD Primary Customers Water Use Profile (Chapter 4)

To make recommendations that are technically sound and economically feasible, water conservation planners must understand the customer makeup and water use patterns of the service area. Historical water use by the four primary customers and their successive customers was obtained from TRWD and from utility profiles (Figure ES-1). The customer utility profiles contain additional water use information that can be used to further break down historical water use by residential, commercial, industrial, other, and nonrevenue water uses. For the period 2004 to 2008, the customer utility profiles account for 81.5 to 86.9 percent of the water that TRWD delivered to the four primary customers. Because this represents the large majority of water used by the four primary customers, conclusions based on the reported data will be generalized to all TRWD water used by the four primary customers.

Water Sales by Sector (Section 4.2)

The utility profiles report water sales by residential, commercial, industrial, wholesale, and other sectors. For 2004 to 2008, Figure ES-2 shows the weighted average distribution of water sales by customer type for the four primary customers. Residential sales comprise 59.6 to 66.8 percent of retail water sales, commercial sales comprise 24.1 to 31.6 percent, and industrial sales comprise 4.5 to 7.2 percent.

Per-Capita Water Use (Section 4.3)

Total annual water use by the four primary customers is normalized by their populations in Figure ES-3. Some of the variability in annual water use can be attributed to differences in weather from year to year. To better filter out the impact of weather on the annual data, five-year running averages were calculated (Figure ES-3). The five-year running average has declined from 195.8 gpcd in 2002 to 175.8 gpcd in 2011, a decrease of about 1.1 percent per year.

Reported residential water sales are normalized by population in Figure ES-4. Given the available water use data, it is not feasible to separate indoor and outdoor residential water use. The range of residential water sales during the period 2004 to 2008 was about 82 gpcd to 109 gpcd.

Nonrevenue Water and Water Loss (Section 4.4)

Based on the reported data, the calculated average nonrevenue water for the four primary TRWD customers ranged from 12.7 percent to 17.2 percent of total water diversions, depending on the year. Data quality control issues suggest that the actual nonrevenue water percentages are somewhat greater.

Figure ES-1: Water Use by TRWD's Primary Customers and Their Successive Customers

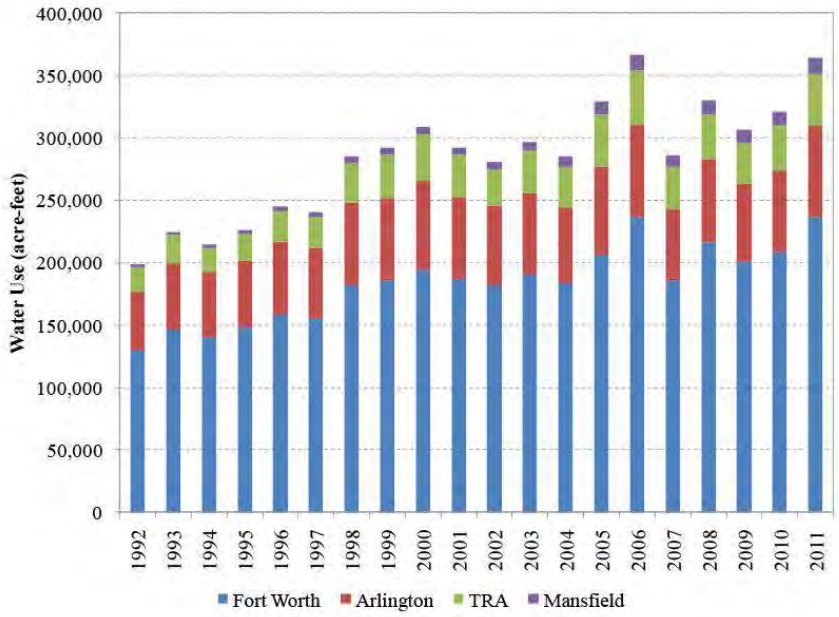


Figure ES-2: Weighted Average Retail Water Sales Distribution by Customer Type for the Four Primary Customers

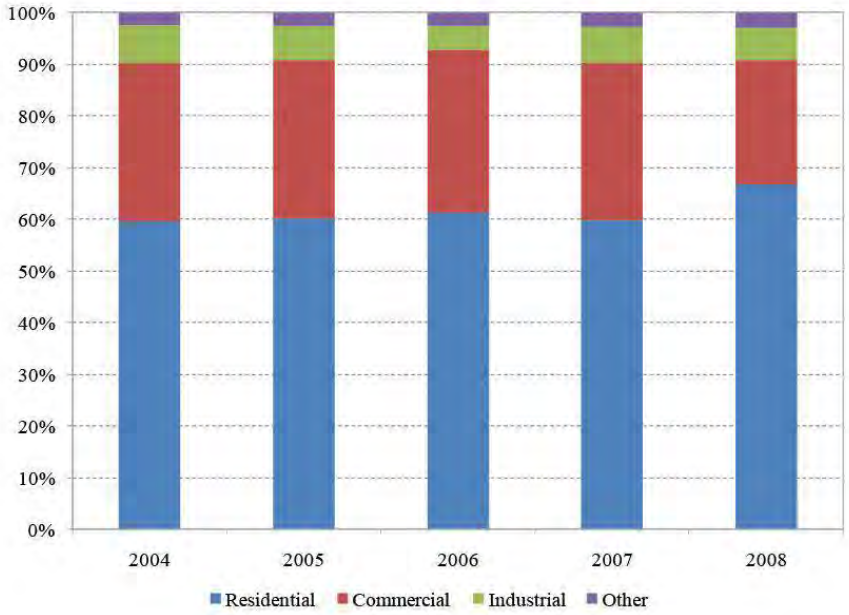


Figure ES-3: Total Water Use Normalized by Population for the Four Primary Customers

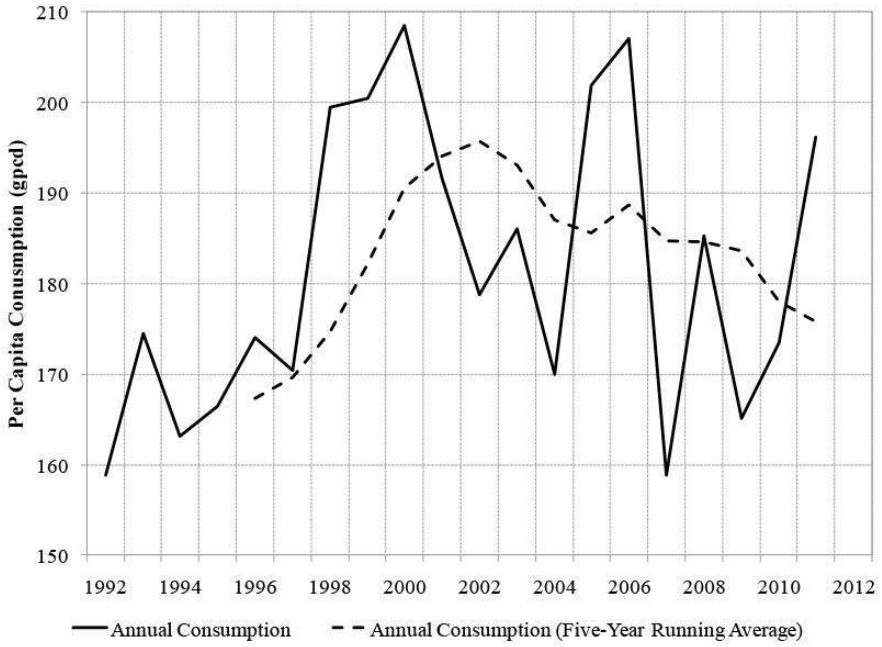
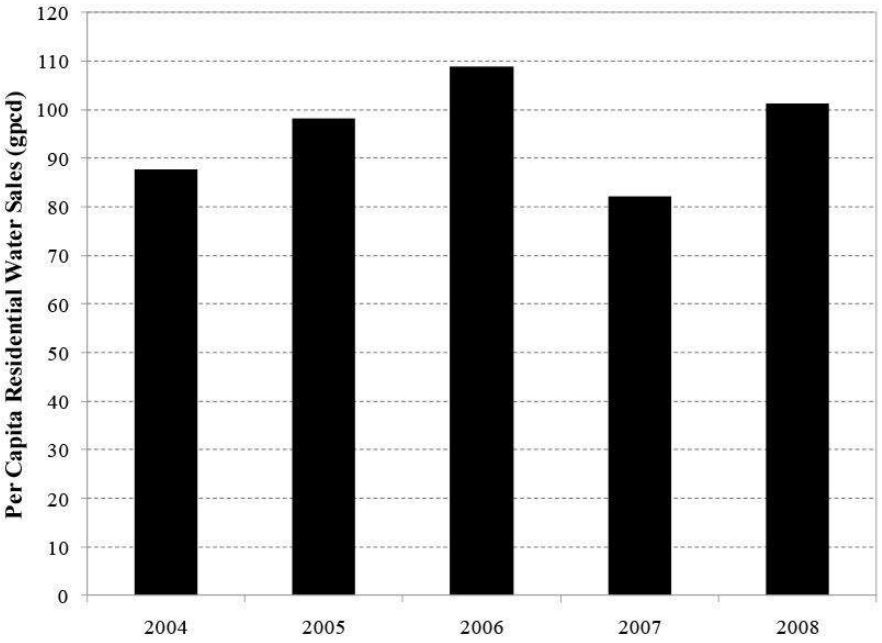


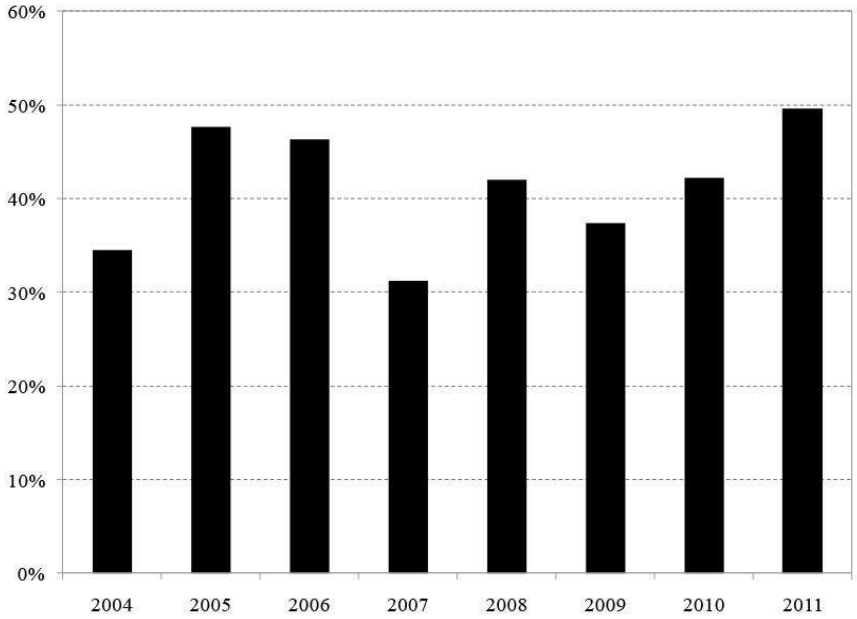
Figure ES-4: Residential Water Sales Normalized by Population for Reporting Customers



Seasonal Water Use (Section 4.5)

On an annual basis, the four primary customers use 31 percent to 50 percent of their water for seasonal uses (Figure ES-5), depending on climatic conditions. Seasonal water uses include lawn irrigation, cooling water, and other water uses that increase in the summer. The customers use more water for seasonal uses during hot, dry conditions.

Figure ES-5: Seasonal Water Use as a Percentage of Total Water Use for the Four Primary Customers



NOTE: Seasonal water uses include lawn irrigation, cooling water, and other water uses that increase in the summer.

ES.3. Identification and Screening of Potential Water Conservation Measures (Chapter 9)

Potential water conservation measures were compiled from various sources, including recommendations by task forces and planning groups, literature sources, and successful regional water conservation programs implemented by other utilities. Potential water conservation measures are presented in Appendix E.

Based on the TRWD water use profile, screening criteria were developed to help determine which new or enhanced water conservation measures would be most effective for the TRWD service area during the next five years. Using these screening criteria, the measures in Table ES-1 were selected for detailed evaluation of probable water savings, benefits, and costs. These measures address a broad range of customer types and water use types.

Table ES-1: Water Conservation Measures Selected for Detailed Evaluation

	Measure	Customer Type				Use Type		Measure Type			
		SF	MF	ICI	Municipal/ Utility	Indoor/ Base	Outdoor/ Seasonal	Education/ Outreach	Rebate/ Incentive	Regulation	Other
1	High-efficiency toilet (HET) distribution/incentives	✓	✓	✓		✓			✓		
2	Toilets, natural replacement with HETs	✓	✓	✓		✓				✓	
3	High-efficiency clothes washer (HECW) incentives	✓	✓	✓		✓			✓		
4	Residential clothes washers, natural replacement with HECWs	✓	✓			✓				✓	
5	Pre-rinse spray valve retrofits			✓		✓			✓		
6	ICI customer water audits			✓		✓		✓			
7	Site-specific ICI incentives			✓		✓	✓		✓		
8	Cooling tower incentives			✓			✓		✓		
9	ICI recognition program			✓		✓	✓	✓			
10	Irrigation system evaluations	✓	✓	✓			✓	✓			
11	Irrigation system incentives	✓	✓	✓			✓		✓		
12	Rainwater harvesting incentives	✓	✓	✓			✓		✓		
13	Irrigation limits: maximum 2 times per week	✓	✓	✓			✓	✓		✓	
14	Public education (ET irrigation recommendations)	✓	✓	✓			✓	✓			
15	Golf course conservation and reuse			✓	✓		✓	✓			
16	Model landscape ordinance	✓	✓	✓	✓		✓	✓		✓	
17	Water loss reduction			✓	✓	✓		✓			
18	Water use reduction due to increases in real water price	✓	✓	✓		✓	✓				✓
19	Wholesale customer assistance	✓	✓	✓		✓	✓		✓		
20	Model conservation ordinance	✓	✓	✓	✓	✓	✓	✓		✓	
	NUMBER OF MEASURES	13	13	18	4	12	13	9	8	5	1

SF = Single-family residential
MF = Multi-family residential
ICI = Industrial, commercial, and institutional

ES.4. Detailed Evaluation of Selected Water Conservation Measures (Chapter 10)

The goals of the Strategic Plan are to:

- Develop and implement water conservation programs aimed at:
  - Decreasing per capita water use (gpcd)
  - Reducing seasonal peak demands
  - Reducing water loss and waste
- Target an average one percent per year reduction in the five-year average per capita consumption for the five-year planning period (Figure 10-1).[2] This results in an 8.6 gpcd reduction over five years. This target is exclusive of any credit for indirect reuse diversion volumes (see Section 8.2). This goal is consistent with the recommendations of the statewide Water Conservation Implementation Task Force (Ref. 7) and with TRWD's published 2018 water use goal of 166 gpcd (Table 6-1 and Ref. 3).
- Continue a heightened public awareness of water conservation in the TRWD service area and the North Texas region.
- Continue and enhance conservation practices that will maintain quality of life and allow economic growth and development.
- Continue to include broad-based public and private stakeholder groups in new program development and implementation processes.
- Continue to lead by example by upgrading TRWD facilities with water-efficient fixtures, landscapes, and irrigation systems wherever possible.
- Assist in facilitating regional conservation efforts among TRWD customer cities.
- Establish the foundation for continuation of water savings targets for the following five-year period and succeeding five-year intervals.

The measures listed in Table ES-1 were evaluated based on the following:

- TRWD's water conservation goals for the next five years
- Projected water savings
- Probable benefits
- Probable costs
- Feedback from wholesale customer cities.

[2] Assumes that existing water conservation measures will maintain the existing five-year average per capita water consumption until 2013, when the first recommended water conservation measures from this Strategic Plan will be implemented.

ES.5. Recommended Implementation Plan, 2013 through 2017 (Chapter 11)

Considering how effective TRWD's water conservation program has been over the last several years (Figure ES-3), all of the water conservation measures presently employed by TRWD are recommended for continuation through the planning period. In addition, it will be important to use the multimedia public outreach campaign to educate the public about new measures as they are implemented and to encourage participation.

The recommended implementation schedule for the next five years (Table ES-2 and Figure ES-6) is based on the following prioritization criteria for new water conservation measures:

- Implement the more cost-effective measures early. However, if necessary, delay implementation while working to increase public acceptance.
- Implement measures with higher water savings early.
- Limit the number of programs to be planned/implemented each year based on the capacity of the existing water conservation staff.
- Align strategies that have similarities/synergies.

The following recommendations are given in support of the implementation schedule (Table ES-2):

- As soon as possible, TRWD should develop a model conservation ordinance and encourage customers to adopt and enforce the ordinance.
- TRWD is already working to implement the public education (ET irrigation recommendations) measure. The golf course conservation measure will build on this measure by encouraging golf courses to use the ET irrigation recommendations. Both of these are relatively low-cost measures, and they are also recommended for implementation in 2013.
- TRWD should develop a model ordinance restricting irrigation to a maximum of two times per week and encourage customers to adopt and enforce the ordinance. This measure would make permanent the irrigation restriction that TRWD activated from August 29, 2011 through May 3, 2012 as part of Stage 1 of its Drought Contingency Plan. Although this measure is projected to have substantial water savings, implementation should be delayed until 2014 to allow TRWD to work with its wholesale customers to communicate the benefits of a twice-weekly watering limitation to council and board members, other decision-makers, and the public.
- Although the high-efficiency toilet distribution/incentives measure is the most cost-effective active measure in the long-term, it will require substantial budget increases. Since there is not sufficient time remaining to increase the budget for 2013, it is recommended that the high-efficiency toilet distribution/incentives measure be implemented in 2014.
- TRWD should create an "ICI Device Incentives Menu" to promote use of water-efficient fixtures and equipment by a large number of ICI customers. This menu would begin with implementation of high-efficiency toilet distribution/incentives in 2014 and would

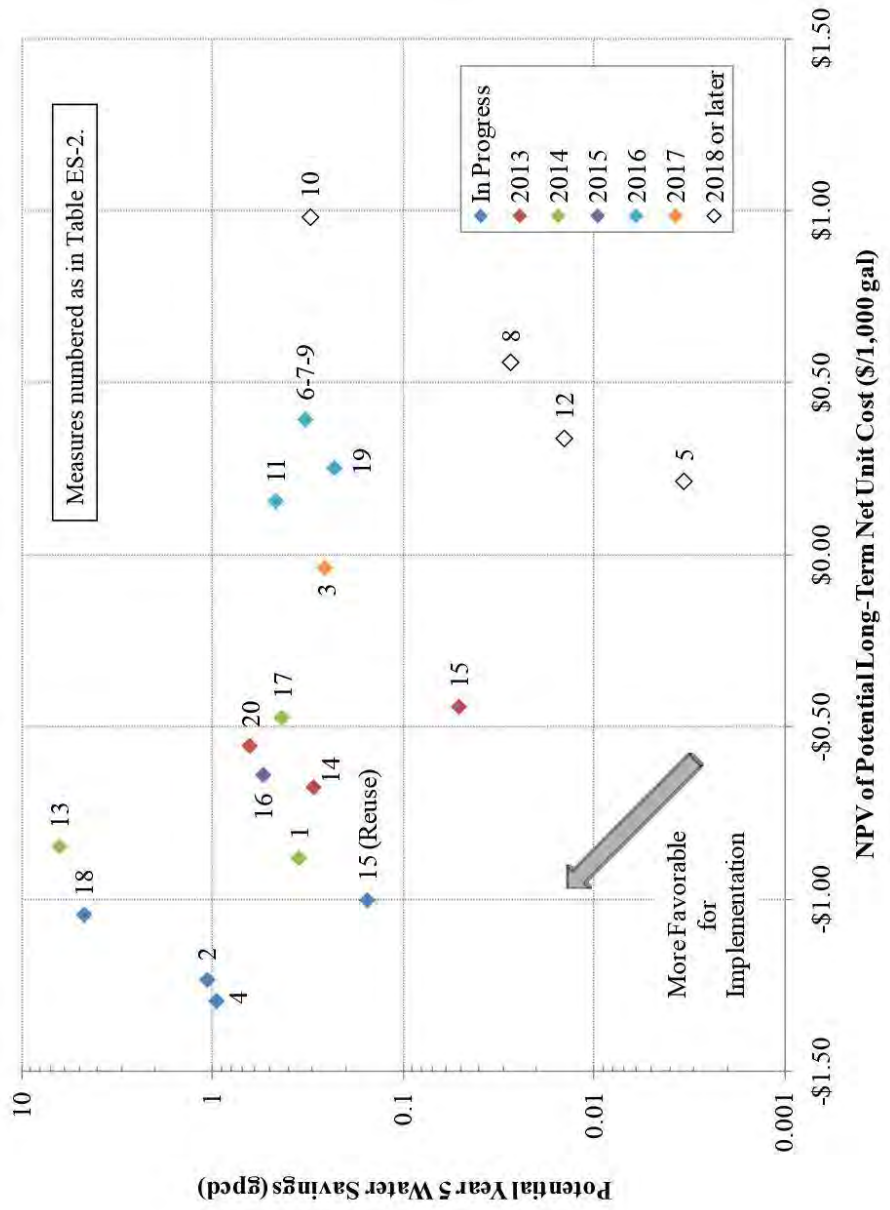
expand in later years to include high-efficiency clothes washer incentives and irrigation system incentives.

Table ES-2: Recommended Implementation Schedule for Evaluated Measures

	Measure	Year				
		2013	2014	2015	2016	2017
2	Toilets, natural replacement with HETs					
4	Residential clothes washers, natural replacement with HECWs					
15	Golf course reuse (natural implementation)*					
18	Water use reduction due to increases in real water price					
14	Public education (ET irrigation recommendations)					
20	Model conservation ordinance					
15	Golf course conservation					
13	Irrigation limits: maximum 2 times per week	X				
1	Residential high-efficiency toilet (HET) distribution/incentives	X				
1	*Create ICI device incentives menu:* High-efficiency toilet (HET) distribution/incentives	X				
17	Water loss reduction	X				
16	Model landscape ordinance	X	X			
11	*Add measure to ICI device incentives menu:* Irrigation system incentives			X		
11	Residential irrigation system incentives			X		
19	Wholesale customer assistance			X		
6 7 9	*Site-specific ICI customer program:* ICI customer water audits Site-specific ICI incentives ICI recognition program			X		
3	Residential high-efficiency clothes washer (HECW) incentives				X	
3	*Add measure to ICI device incentives menu:* High-efficiency clothes washer (HECW) incentives				X	
8	*Add measure to ICI device incentives menu:* Cooling tower incentives					X
10	Irrigation system evaluations	Y	Y	Y	Y	X
12	Rainwater harvesting incentives					
5	Pre-rinse spray valve retrofits					

*: Natural conversion of golf course irrigation from raw or potable water to reclaimed water.
X: TRWD staff will perform final planning of measures in the years before implementation.
Y: TRWD will continue its pilot irrigation system evaluation program.

Figure ES-6: Implementation Schedule, Cost-Effectiveness, and Water Savings



- TRWD should also create (by 2016) a "Site-Specific ICI Customer Program" that would provide in-depth assistance to individual ICI customers that desire it. This program would include the ICI customer water audits, site-specific ICI incentives, and ICI customer recognition measures. This program, and the ICI Device Incentives Menu described above, would complement the SmartWater ICI Audits program that Fort Worth implemented in 2010 by expanding audits to other cities and by making it more cost-effective for ICI water users to upgrade equipment. Examples of Fort Worth's success with this program are cited in Section 7.3.
- Since TRWD staff will be busy implementing the irrigation system incentives in 2016, the high-efficiency clothes washer incentives should be delayed until 2017.
- Although implementation of the irrigation system evaluations is not recommended until 2018 (after the five-year planning period), TRWD should begin final planning for this measure in 2017.
- Given the number of programs that TRWD must develop to meet the recommended schedule and the relatively low projected water savings from the pre-rinse spray valve retrofits, rainwater harvesting incentives, and cooling tower incentives, these measures are not recommended for implementation in the next five years.

Projected Water Savings, Benefits, and Costs (Section 11.2)

By 2017, the recommended implementation plan is projected to achieve the following water savings, benefits, and costs:

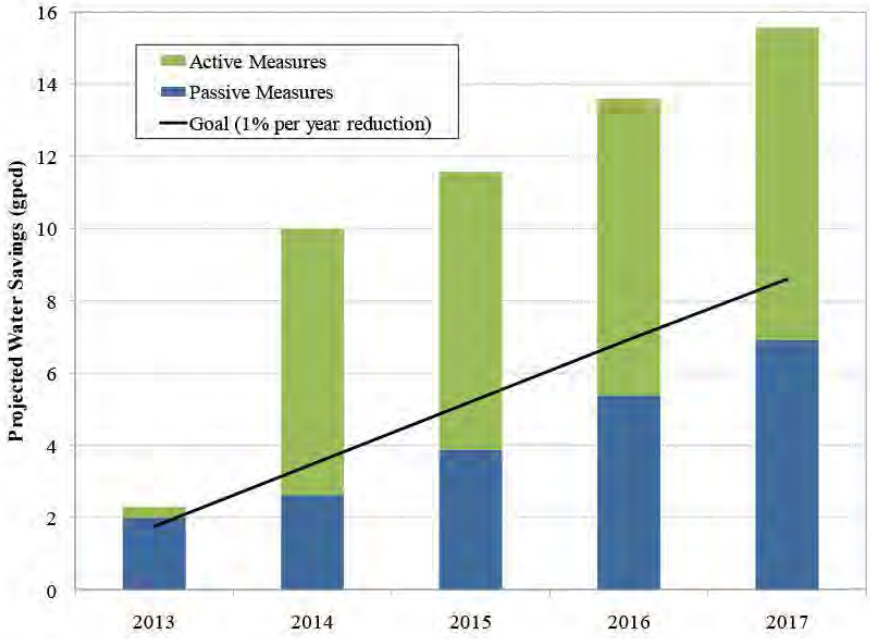
- Annual water savings of 30.1 mgd, which is 56 percent greater than the projected conservation savings (about 19.3 mgd) in the 2011 Region C Water Plan (Ref. 1).
- Annual per-capita water savings of 15.6 gpcd (Figure ES-7).
- Cumulative benefits of about $30.9 million (Figure ES-8).
- Cumulative costs to utilities of about $14.4 million (Figure ES-8).
- Cumulative benefit-cost ratio of about 2.1 (Figure ES-8).

The projected water savings from the implementation plan are in addition to the water savings that have already been achieved (an average of 23.2 mgd from 2007 through 2011). Therefore, it is projected that continuation of TRWD's existing water conservation measures and implementation of the recommended measures will achieve a total water savings of approximately 53.3 mgd compared to 2006 water use. At the projected five-year average per capita water demand (165.1 gpcd), these water savings would stretch the existing water supply enough to meet the needs of an additional 322,800 people by 2017. Placed in a different context, these water savings equal approximately 21 percent of the annual yield that TRWD could potentially obtain from the future Marvin Nichols Reservoir (Ref. 1).

The implementation plan would reduce projected per capita water use and, therefore, could either delay the need for additional water supplies or allow TRWD to downsize its share of future water supply projects. By 2030, the implementation plan could delay the need for additional water

supplies by as many as 9 years. As described in Section 10.5, construction of future water supplies is expected to be a cooperative effort between TRWD and other agencies. Since other agencies might not be able to defer construction of new water supply facilities, it has been assumed, for the purpose of evaluating the cost-effectiveness of potential water conservation measures, that TRWD will downsize its share of each planned future water supply according to the projected water conservation savings during a severe drought. Either way, the recommended water conservation implementation plan is cost-effective compared to developing additional water supplies.

Figure ES-7: Projected Per-Capita Water Savings



It is also assumed that Fort Worth and Arlington will continue their existing water conservation measures. Although TRWD will realize additional savings from these measures, additional savings from existing Fort Worth and Arlington measures have not been estimated and are not included in Figure ES-7.

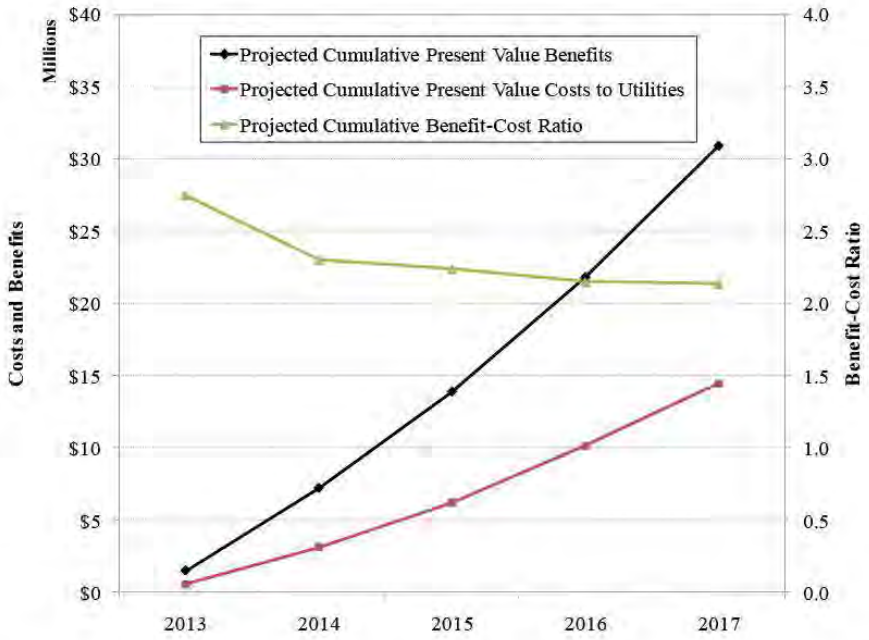
Recommended New Labor Resources (Section 11.3)

TRWD will implement some of the recommended water conservation measures (e.g., the ordinance measures) with existing staff members.[3] The remaining recommended measures will require new labor resources to effectively implement the Strategic Plan. New labor resources

[3] TRWD's customers may have to add staff members to implement some of the measures, particularly for ordinance enforcement.

could consist of additional TRWD staff members and/or retaining contractors. During the final planning stage for each recommended measure, TRWD will decide whether to add staff or retain contractors. Table ES-3 presents the overall new labor resource requirements in terms of full-time equivalent (FTE) positions, summarized by strategy and year. It is anticipated that additional labor resources equivalent to 6 FTEs will be required to effectively implement the recommended measures during the five-year implementation period.

Figure ES-8: Projected Present Value Benefits and Costs to Utilities



The recommended new labor resources have been based on customer participation assumptions and staff time required for similar programs at other utilities. Each of the recommended water conservation measures should be reviewed annually to verify that customer participation and the production capacity of the existing staff continue to warrant the recommended new labor resources.

Recommended TRWD Water Conservation Budgets (Section 11.4)

Recommended TRWD water conservation budgets are presented for the next five years in Table ES-4. TRWD budgets do not include costs borne by the wholesale customers, such as enforcement of regulations. The recommended budgets are designed to give TRWD the flexibility to either add staff or retain contractors to implement the recommended water conservation measures.

Table ES-3: Recommended New Labor Resources

Recommended Water Conservation Measures[a]	Recommended New Labor Resources (FTEs)[b,c]					
	2013	2014	2015	2016	2017	Five-Year Total
Toilet retrofits - Clerical		+1.50				+1.50
Irrigation system incentives - Clerical				+1.00		+1.00
Wholesale customer assistance - Application review, installation/savings verification				+0.25		+0.25
Site-specific ICI customer program - ICI water audits, installation/savings verification				+2.75		+2.75
Clothes washer retrofits - Clerical					+0.50	+0.50
TOTAL	**+0.00**	**+1.50**	**+0.00**	**+4.00**	**+0.50**	**+6.00**

[a] Some recommended water conservation measures/tasks are not shown, because it is assumed that TRWD will implement them using existing staff members.
[b] TRWD can either add staff members or retain contractors to implement these measures.
[c] Does not include staff increases for TRWD customers.

Table ES-4: Recommended TRWD Water Conservation Budget

Water Conservation Measures		Recommended TRWD Water Conservation Budget[a]				
		2013	2014	2015	2016	2017
2	Toilet natural replacement	$0	$0	$0	$0	$0
4	Clothes washer natural replacement	$0	$0	$0	$0	$0
15	Golf course reuse (natural implementation)	$0	$0	$0	$0	$0
18	Water use reduction - price	$0	$0	$0	$0	$0
14	Public education (ET)[c]	$2,000	$2,000	$2,000	$2,000	$2,000
20	Model conservation ordinance[b]	$0	$0	$0	$0	$0
15	Golf course conservation	$7,000	$7,000	$7,000	$8,000	$8,000
13	Irrigation limits 2/week[b]	-[c]	$0	$0	$0	$0
1	Toilet retrofits[d]	-[c]	$1,215,000	$1,237,000	$1,259,000	$1,282,000
17	Water loss reduction	-[c]	$122,000	$43,000	$44,000	$45,000
16	Model landscape ordinance[b]	-[c]	-[c]	$0	$0	$0
11	Irrigation system incentives	-	-	-[c]	$638,000	$666,000
19	Wholesale customer assistance	-	-	-[c]	$237,000	$229,000
6-7-9	Site-specific ICI customer program[d]	-	-	-[c]	$384,000	$395,000
3	Clothes washer retrofits	-	-	-	-[c]	$602,000
10	Irrigation system evaluations[d]	-[e]	-[e]	-[e]	-[e]	-[c,e]
Subtotal		***$9,000***	***$1,346,000***	***$1,289,000***	***$2,572,000***	***$3,229,000***
Continue existing TRWD programs		$1,649,000	$1,679,000	$1,710,000	$1,741,000	$1,773,000
Update Strategic Water Conservation Plan		-	-	-	$380,000	-
Total Water Conservation Budget		**$1,658,000**	**$3,025,000**	**$2,999,000**	**$4,693,000**	**$5,002,000**

[a] Costs inflated at an annual inflation rate of 1.8 percent per year (see Appendix J for discussion).
[b] Existing TRWD staff members will develop the model ordinances and coordinate customer adoption.
[c] Existing TRWD staff members will perform final planning and development of measures the year before implementation.
[d] TRWD will coordinate with existing Fort Worth and Arlington measures. The recommended budgets are for water conservation activities (toilet retrofits, ICI water audits, etc.) beyond those established and implemented by the Fort Worth and Arlington water conservation programs.
[e] Assumes that TRWD will continue its pilot irrigation system evaluation program. The pilot program is included in the "continue existing TRWD programs" line item.

The recommended budgets are the probable amounts that TRWD must spend on each strategy to achieve the projected water savings (Figure ES-7). In addition, TRWD should continue to fund its existing water conservation measures at existing levels (adjusted for inflation). The recommended total water conservation budgets range from $1.66 million in 2013 to $5.00 million in 2017.

Although it is recommended that TRWD proceed with implementation of recycled water projects to increase water efficiency, recycled water planning has been conducted separately from water conservation planning, and no budget recommendations for recycled water projects have been developed as part of the Strategic Plan.

APPENDIX H

TRWD WHITE PAPER: CONSIDERATION OF LIMITING OUTDOOR IRRIGATION SCHEDULES TO TWICE PER WEEK

FEBRUARY 2012

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APPENDIX H
TRWD White Paper: Consideration of Limiting Outdoor Irrigation Schedules to Twice Per Week

The water supplies we depend on are not endless resources. For one thing, drought conditions are just a part of life here in North Texas. And the number of people living in our region is expected to double in the next 50 years. That means the demand for water will certainly rise - and meeting that demand in a sustainable way will be a challenge.

In the past, building a reservoir was a sure answer to increasing water supplies. Today, there are no shortcuts - the alternatives for developing new water supplies are limited, expensive and time consuming. Couple that with the potential for severe droughts (like the one in 2011) and a steadily increasing population and conservation offers the quickest and cheapest way to relieve the strain on water supplies and meet the new water needs of our growing communities.

A good place to start saving water is by changing our outdoor irrigation habits. Outdoor water use, particularly lawn watering, can account for half or more of annual residential water use - and much more than that during the hot, dry Texas summers. In North Texas cities, average summer water demands can spike to more than 80% above average winter consumption.[1] It's a common scenario observed around the country.

The main culprit is a homeowner's tendency to over-water. Haley et al. (2007) showed that overall homeowners over-watered as much as 2-3 times the amount needed by plants, based on estimates of climate demand.[2] This study also reported that although homeowners use significantly less water in the winter months, when plant water requirements are at a minimum, they are still prone to over-irrigate.

One successful strategy to lower water use being pursued by communities nationwide is placing limitations on outdoor irrigation to no more than twice per week. The goal is to reduce excessive outdoor watering and water waste, especially during peak summer months when rain is scarce and demands are high. The savings here in North Texas would be tremendous - millions of gallons of highly treated drinking water per day; billions of gallons per year.

In September 2011, following the declaration of Stage 1 drought restrictions and twice per week watering limitations (Aug. 29, 2011), the water district observed an average decline in daily water demands of eight percent among its Tarrant County customers. Water use declined 35-45 million gallons per day after the restrictions were put in place compared to the daily water demands in the weeks leading up to Stage 1.

A study examining mandatory irrigation schedules during the 2002 Colorado drought found that restrictions were effective and produced significant water savings.[3] Net savings ranged from 15 to 55 percent on a per capita basis. The greatest savings were achieved by cities implementing the most aggressive restrictions. Cities with twice-a-week schedules reported a savings of 31 percent based on per capita use.[4]

Similarly in Florida, a literature review by Olmsted (2008) revealed that day-of-the-week watering restrictions were effective, in most cases.[5] In Hillsborough and Orange counties, utilities reported water use reductions of 17-18 percent; however no reductions were seen in Seminole County.[6]

In March 2011, the driest dry season in 80 years prompted South Florida water managers to declare a water shortage and impose two-day-per-week watering restrictions. The City of Stuart, Florida, already under a self-imposed two-day-a-week watering schedule in 2010, reported the restrictions were "proving to be water savers."[7] Daily consumption in Stuart dropped from 219 to 185 gallons on a per person basis - a water savings of more than 15 percent.

Day-of-week restrictions do not come without their drawbacks. Dukes et al. (2011) assert they may encourage over-watering on the allowed day. And they do not guarantee that water is being applied at the right time, in the right amount. So it is essential that we educate on proper irrigation application rates and scheduling to realize the best savings possible.

Concerns about plant survival in North Texas can be alleviated by the fact that landscapes don't need to be watered more than once per week during a majority of the year. And oftentimes watering isn't necessary at all.

The City of Frisco, Texas uses a weather station and rain gauges to provide residents with weekly watering recommendations based on climate conditions - something the Tarrant Regional Water District is working to put in place. During 2010, the city advised Frisco residents that their lawns didn't need any supplemental irrigation 25 out of 52 weeks.[8] Any outdoor irrigation taking place during those weeks was above what was required by landscapes and therefore wasteful. In addition, the city only recommended watering more than once per week during three of those weeks.

The situation was quite different for Frisco residents during the record drought of 2011. With rainfall amounts on the decline and heat on the rise, the city recommended a twice-per-week schedule 11 weeks during the year; a once per week schedule during 8 of those weeks; and that Mother Nature provided what landscapes needed the remaining 33 weeks of the year. The message to residents and to water suppliers is clear: we pour way too much water on our landscapes.

Another positive for plant survival using a twice-per-week watering schedule is our clay soil, the dominant soil type throughout the Metroplex. From a gardener's standpoint, it may be frustrating to work with. But from a landscape standpoint, clay soil retains moisture, which allows for longer spans between waterings.

Despite the evidence, placing limits on outdoor irrigation is not an easy choice. But it can also be easily argued that overwatering to the tune of millions of gallons a week isn't an acceptable choice either.

The Colorado study (Kenney, et al., 2004) suggests that "conservation programs based on mandatory, twice weekly landscape watering restrictions provide an attractive balance between saving water and limiting the impact on customers..."[9] But, to ensure the program's success will take a substantial level of commitment. It requires a willingness to enforce restrictions and a huge effort to promote and educate. Halich et al. (2005) showed that in Virginia the intensity in which water use restrictions are implemented clearly had in impact on lowering water use.[10]

By taking a regional approach to implementing twice-per-week watering restrictions, we can limit confusion and simplify the education of water users across all communities. The Tarrant Regional Water District is committed to reducing water waste and stretching our water supplies to meet the future water needs of our growing communities. Adopting a twice per week watering strategy will be an immense step towards embracing a more responsible use of our water resources.

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[1] McCormick, Lacy and Jennifer Walker, 2010. Sprayed Away Seven Ways to Reduce Texas' Outdoor Water Use. Wildlife Federation, Sierra Club. Retrieved January 26, 2012 from http://www.texaswatermatters.org/pdfs/sprayed%20away_report.pdf.

[2] Haley, Melissa B., Michael D. Dukes, Grady L. Miller, 2007. Residential Irrigation Water Use in Central Florida. Journal of Irrigation and Drainage Engineering 133(5): 427-434.

[3] Kenney, Douglas S., Roberta A. Klein, and Martyn P. Clark, 2004. Use and Effectiveness of Municipal Water Resources During Drought in Colorado. Journal of American Water Resource Association (JAWRA) 40 (1):77-87.

[4] Ibid.

[5] Dukes, Michael D., Laurie E. Trenholm, Ed Gilman, Chris J. Martinez, John L. Cisar, Thomas H. Yeager, Amy Shober and Geoffrey Denny, 2008. Reviewed May 2011. Frequently Asked Questions about Landscape Irrigation for Florida-Friendly Landscaping Ordinances. Environmental Horticulture Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Retrieved January 26, 21012 from https://edis.ifas.ufl.edu/wq142.

[6] Ibid.

[7] Seltzer, Alexandra, 2011, March 22. South Florida Water Managers Restrict Lawn Watering to Twice a Week. *Palm Beach Post*. Retrieved January 26, 2012 from http://www.tcpalm.com/news/2011/mar/22/south-florida-water-managers-restrict-lawn-to-a/.

[8] Hartwell, Gary, Public Works Director, City of Frisco. Personal communication. May 3, 2011.

[9] Ibid. 3.

[10] Halich, Greg, Kurt Stephenson, and Christiana Hilmer, 2005. The Effectiveness of Mandatory and Voluntary Water-Use Restrictions During DroughtDepartment of Agricultural and Applied Economics, Virginia Polytechnic Institute and State University. Prepared for American Agricultural Economic Association Annual Meeting, Providence, Rhode Island, July 2005.

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APPENDIX I

TWICE PER WEEK LANDSCAPE WATERING ORDINANCE ADOPTED BY FORT WORTH CITY COUNCIL

APRIL 8, 2014

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APPENDIX I

Twice per Week Landscape Watering Ordinance Adopted by the Fort Worth City Council, April 8, 2014

ORDINANCE NO. _____

AN ORDINANCE AMENDING CHAPTER 35, "WATER AND SEWERS", OF THE CODE OF THE CITY OF FORT WORTH (1986), AS AMENDED BY AMENDING ARTICLE I, "GENERAL", SUBSECTION (b) OF SECTION 23 "EMERGENCY AUTHORITY" BY REPLACING EXHIBIT A ATTACHED AND ADOPTING A REVISED DROUGHT CONTINGENCY/EMERGENCY WATER MANAGEMENT PLAN; BY AMENDING ARTICLE VI "LAWN AND LANDSCAPE IRRIGATION CONSERVATION", SECTION 35-151 "LAWN AND LANDSCAPE IRRIGATION RESTRICTIONS" TO MANDATE TWICE PER WEEK WATERING AND IRRIGATION AND TO PROVIDE FOR A VARIANCE PROCESS; PROVIDING THAT THIS ORDINANCE SHALL BE CUMULATIVE; PROVIDING A SEVERABILITY CLAUSE; PROVIDING A PENALTY CLAUSE; PROVIDING FOR PUBLICATION; AND PROVIDING AN EFFECTIVE DATE.

WHEREAS, the City Council finds that conservation of water and protection of water supplies are in the best interest of its citizens; and

WHEREAS, the City is required to submit updated water conservation and drought contingency and emergency water management plans to the Texas Commission on Environmental Quality (TCEQ) and the Texas Water Development Board by May 1, 2014 in accordance with Title 30 of the Texas Administrative Code, Chapter 288; and

WHEREAS, staff recommends that the City Council adopt the amended drought contingency and emergency water management plan referenced in Section 35-23(b) of the City Code; and

WHEREAS, in an effort to increase water conservation efforts and at the request of Tarrant Regional Water District, staff also recommends amending the Water and Sewers Code, Article VI Lawns and Landscape Irrigation Conservation, Section 35-151, to provide for permanent, year round twice per week watering and irrigation restrictions and a variance procedure; and

WHEREAS, the Water Conservation Plan proposes a goal of reducing the rolling five year average water consumption to a level of 160 gallons per capita per day by 2020 and 152 gallons per capita per day by 2025; and

WHEREAS, securing future water supplies will require proving to state permitting agencies that existing water supplies are being used efficiently.

NOW THEREFORE BE IT ORDAINED BY THE CITY COUNCIL OF THE CITY OF FORT WORTH, TEXAS:

SECTION 1.

Part II of the Code of the City of Fort Worth, Texas (1986), as amended, Chapter 35, "Water and Sewers", Article I, "In General", is hereby further amended to replace the Drought Contingency/Emergency Water Management Plan adopted in Section 23 "Emergency Authority", Subsection (b) as **Exhibit A** with the revised **Exhibit A** attached to this ordinance and incorporated herein for all purposes.

SECTION 2.

Part II of the Code of the City of Fort Worth, Texas (1986), as amended, Chapter 35, "Water and Sewers", Article VI, "Lawn and Landscape Irrigation Conservation"**,** Section 35-151, "Lawn and Landscape Irrigation Restrictions" is hereby further amended to read and be as follows:

SECTION 35-151. Lawn and Landscape Irrigation Restrictions.

(a) Except for hand watering, drip irrigation and the use of soaker hoses, a Person may only irrigate, water, or cause or permit the irrigation or watering of any lawn or landscape located on premises owned, leased, or managed by that Person (i) on a day designated as an outdoor water use day for the property's address as shown below; and (ii) between the hours of 12 midnight to 10 a.m. and 6 p.m. to 11:59 p.m. on such day.

(1) Residential addresses ending in an even number (0, 2, 4, 6 or 8) may water on Wednesdays and Saturdays.

(2) Residential addresses ending in an odd number (1, 3, 5, 7 or 9) may water on Thursdays and Sundays.

(3) All non-residential locations (apartment complexes, businesses, industries, parks, street and/or roadway medians, etc.) may water on Tuesdays and Fridays.

(b) Except for hand watering, drip irrigation and the use of soaker hoses, a Person commits an offense if that Person irrigates, waters, or causes or permits the

irrigation or watering of any lawn or landscape located on premises owned, leased, or managed by that Person between the hours of 10:00 a.m. and 6:00 p.m.

(c) Except for hand watering, drip irrigation and the use of soaker hoses, a Person commits an offense if that Person irrigates, waters, or causes or permits the irrigation or watering of any lawn or landscape located on premises owned, leased, or managed by that Person on a day that is not designated as an outdoor water use for that property address as shown in subsection (a) above.

(d) A Person commits an offense if a Person knowingly or recklessly irrigates, waters, or causes or permits the irrigation or watering of a lawn or landscape located on premises owned, leased or managed by the Person in a manner that causes:

(1) a substantial amount of water to fall upon impervious areas instead of a lawn or landscape, such that a constant stream of water overflows from the lawn or landscape onto a street or other drainage area; or

(2) an irrigation system or other lawn or landscape watering device to operate during any form of precipitation.

(e) A Person commits an offense if, on premises owned, leased, or managed by that Person, a Person operates a lawn or landscape irrigation system or device that:

(1) has any broken or missing sprinkler head; or

(2) has not been properly maintained in a manner that prevents the waste of water.

(f) Affirmative Defenses

(1) It shall be an affirmative defense to prosecution of an offense in section 35- 151 (a) that at the time such Person irrigates, waters, or causes or permits the irrigation or watering of any lawn or landscape, such activity was for the purpose of:

(A) dust control of a sports field; or

(B) the maintenance, repair, or testing of an irrigation system.

(2) The activity described in subsection f (1) (A) and (B) may only occur within a period of two (2) days no more than once every thirty (30) days. Any such activity requiring a longer period or greater frequency shall require a variance as provided by subsection (g).

(g) Variances

(1) The water department director or official designee may grant variances to the twice per week watering and irrigation restrictions and schedule, if one or more of the following conditions are met:

(A) Failure to grant such a variance would cause an emergency condition adversely affecting health, sanitation, or fire safety for the public or the Person requesting the variance;

(B) Compliance with the watering and irrigation restrictions and/or schedule cannot be accomplished due to technical or other limitations; or

(C) Alternative methods that achieve the same level of reduction in water use can be implemented.

(2) The water department director or official designee may grant variances to allow for establishment of hydromulch, grass sod, or grass seed for new lawns.

(3) Variances shall be granted or denied at the discretion of the water department director or official designee. All petitions for variances shall be in writing and shall include the following:

(A) Name and address of the petitioner(s);

(B) Purpose of the water use;

(C) Specific provisions from which relief is requested;

(D) Detailed statement of the adverse effect of the provision from which relief is requested;

(E) Description of the relief requested;

(F) Period of time for which the variance is sought;

(G) Alternative measures that will be taken to reduce water use; and

(H) Other pertinent information requested.

(h) A Person who irrigates, waters, or causes or permits the irrigation or watering by use of an alternative water source such as a well, reclaimed or reused water, or water from the Trinity River is exempt from prosecution if that Person has:

(1) Registered such alternative water source with the City;

(2) Provided sufficient proof to the water department director that the alternative water source is from a well, reclaimed or reused water or from the Trinity River and has allowed inspection by the water department director if deemed necessary; and

(3) Complied with the City's Backflow and Cross-connection Control Program and City Code Sections 12.5-525 through 12.5-599.

SECTION 3.
CUMULATIVE PROVISIONS

This ordinance shall be cumulative of all provisions of ordinances and of the Code of the City of Fort Worth, Texas (1986), as amended, except where the provisions of this ordinance are in direct conflict with the provisions of such ordinances and such Code, in which event conflicting provisions of such ordinances and such Code are hereby repealed.

SECTION 4.
SEVERABILITY CLAUSE

It is hereby declared to be the intention of the City Council that the phrase, clause, sentence, paragraph or section of this ordinance are severable and, if any phrase, clause, sentence, paragraph or section of this ordinance shall be declared unconstitutional by the valid judgment or decree of any court of competent jurisdiction, such unconstitutionality shall not affect any of the remaining phrases, clauses, sentences, paragraphs and sections of this ordinance, since the same would have been enacted by the City Council without the incorporation in this ordinance of any such unconstitutional phrase, clause, sentence, paragraph or section.

SECTION 5.
PENALTY CLAUSE

Any person, firm or corporation who violates, disobeys, omits, neglects or refuses to comply with or who resists the enforcement of any of the provisions of this ordinance shall be fined not more than two thousand dollars ($2,000.00) for each offense. Each day that a violation is permitted to exist shall constitute a separate offense.

SECTION 6.
RIGHTS AND REMEDIES

All rights and remedies of the City of Fort Worth, Texas, are expressly saved as to any and all violations of the provisions of the ordinances amended herein, which have accrued at the time of the effective date of this ordinance and, as to such accrued violations and all pending litigation, both civil and criminal, whether pending in court or not, under such ordinances, same shall not be affected by this ordinance but may be prosecuted until final disposition by the courts.

SECTION 7.
PUBLICATION

The City Secretary of the City of Fort Worth, Texas, is hereby directed to publish the caption of this ordinance for two (2) days in the official newspaper of the City of Fort Worth, Texas, as authorized by Section 2, Chapter XXV of the Charter of the City of Fort Worth, Texas and by Section 52.013, Texas Local Government Code.

SECTION 8.
EFFECTIVE DATE

This Ordinance shall take effect upon adoption and publication as required by law.

APPROVED AS TO FORM AND LEGALITY:

By: _____
Christa R. Lopez-Reynolds
Senior Assistant City Attorney

ADOPTED:_____

EFFECTIVE:_____

APPENDIX J

WATER CONSERVATION FACT SHEET INCLUDED IN APPENDIX A OF TRWD INTEGRATED WATER SUPPLY PLAN (2013)

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APPENDIX J

Water Conservation Fact Sheet included in Appendix A of the TRWD Integrated Water Supply Plan

Water Conservation

Description

In planning and developing new water supplies, water conservation strategies across Texas will play a vital role in meeting the projected water needs throughout the state. The 2012 State Water Plan reports that 12 percent of future water needs in Region C will be met through municipal conservation.[1] From a cost standpoint, water conservation is the most cost-effective alternative for meeting new water demands.

The Texas Water Code defines water conservation as "those practices, techniques, and technologies that will reduce the consumption of water, reduce the loss or waste of water, improve the efficiency in the use of water, or increase the recycling and reuse of water so that a water supply is made available for future or alternative uses" (§11.002 (a) (8) (B)). The end result is lower per capita demands and less pressure on existing water supplies. Meaningful reductions in water loss and water waste, and improvements in water efficiency can help TRWD in many ways. Over time, conserving water on a daily basis:

- extends the life of existing supplies to meet new water demands
- slows the drain on reservoirs making more water available during times of drought
- reduces peak supply requirements, which reduces wear and tear on existing infrastructure
- defers increases in capital and operating cost for existing systems, and
- delays the need for developing new water supplies.

Tarrant Regional Water District recognizes the benefits of using water and energy resources more efficiently. In order to maximize the use of existing water resources, TRWD is pursuing a menu of active water conservation measures, not just in times of drought but year-round. Some of the savings TRWD is observing today are due to passive measures that are occurring naturally, such as the replacement of older fixtures and appliances in existing homes with newer, more efficient models. The water district anticipates that the combination of active and passive conservation measures will lead to long-term, permanent reductions in per capita demand. Lower per capita demands is a trend being observed across the country. A national study found that residential water use over the last 30 years has declined at an average rate of 0.44 percent annually.[2]

TRWD is committed to water conservation and has established a program that is generating an annual savings that can be measured in billions of gallons. Water

conservation will continue to play a vital role in the district's long-term water supply strategy.

Strategic Water Conservation Plan

TRWD's Strategic Water Conservation Plan[3] ("Strategic Plan") is designed to serve as a roadmap for developing and implementing water conservation strategies and to provide a way to evaluate their success. The goals of TRWD's water conservation program include reducing per capita use, reducing seasonal peak demands, and reducing water loss and water waste. The target for improving water efficiency is a one percent per year reduction in average water use over a five-year planning period.

The Strategic Plan evaluated the cost and effectiveness of twenty water conservation measures. These particular strategies were screened and selected because of their water savings potential, customer feedback, and their applicability to the majority of customers in the water district's service area. The top six measures projected to generate the highest per capita savings included a combination of active and passive measures[4]:

- Twice per week irrigation limits 6.20 gpcd
- Water use reductions due to price increases 4.74 gpcd
- Natural toilet replacement 1.07 gpcd
- Clothes washer natural replacement 0.96 gpcd
- Model water conservation ordinance 0.62 gpcd
- Wholesale customer water loss reduction 0.42 gpcd

By 2017, the Plan estimates the total per capita savings generated by these measures will be 14.01 gallons per day. These six measures represent 89.8 percent of all the water savings outlined in the Plan.

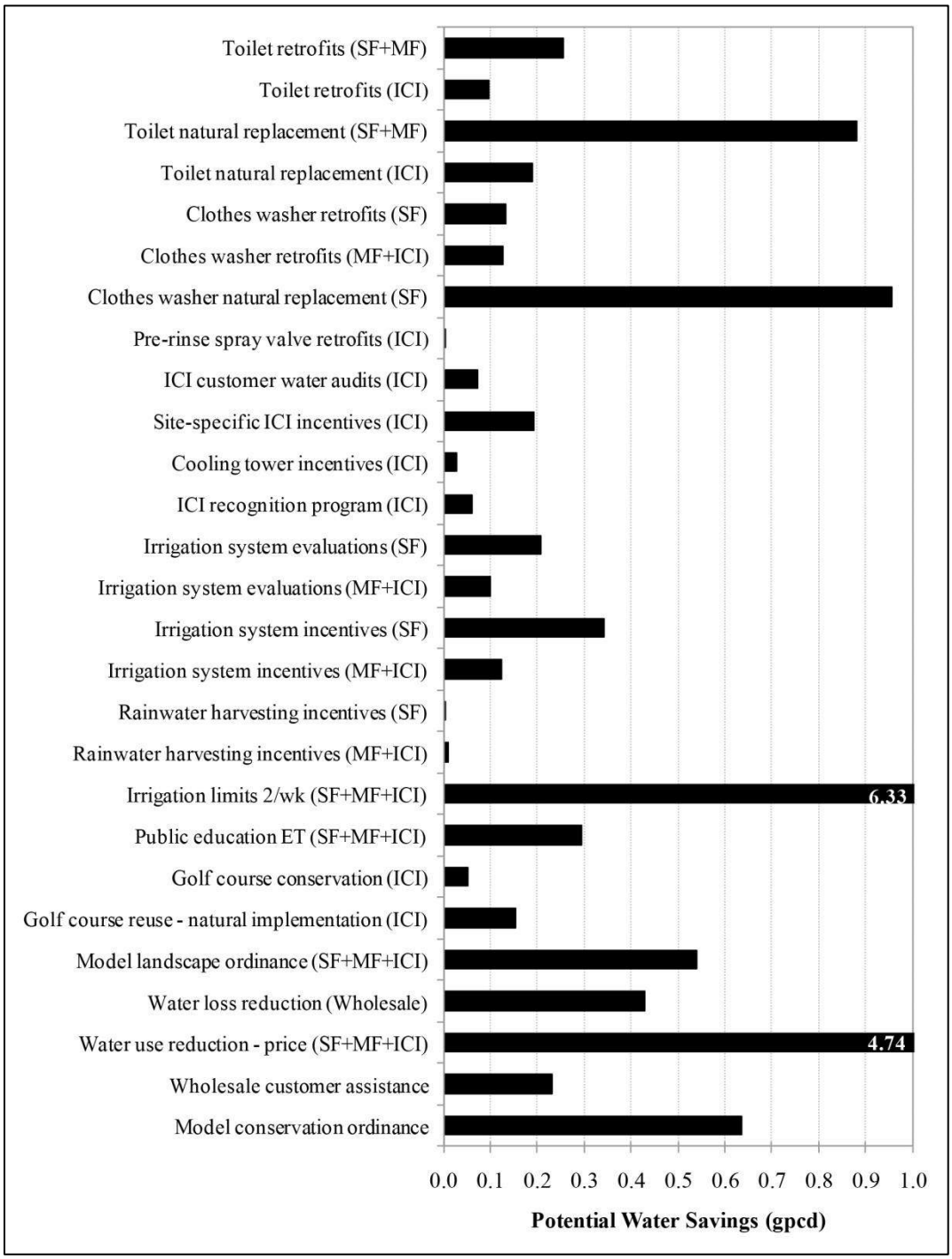

Figure 1: Potential Per Capita Water Savings in Year 5 of the Strategic Plan
Each measure was evaluated by separate categories. SF represents single family residences; MF represents multi-family dwellings, such as apartment complexes; and ICI covers industrial, commercial, and institutional establishments.

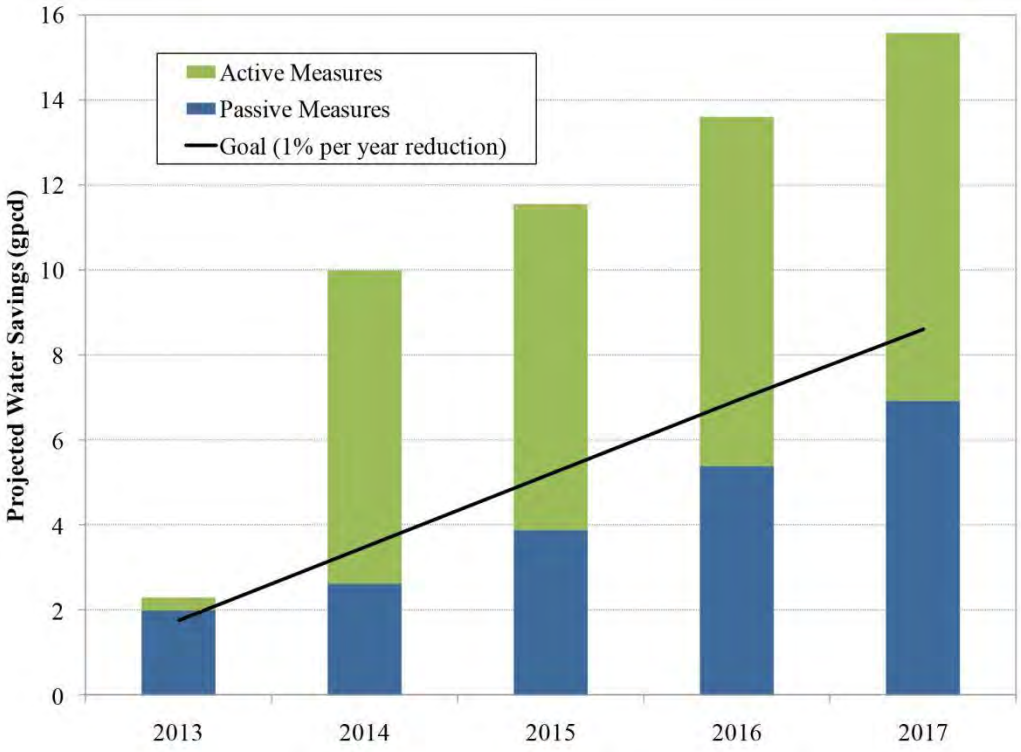

Figure 2: Projected Per Capita Water Savings

Water Conservation Savings

The Strategic Plan includes a model of TRWD annual demands. The model was calibrated using water demands among the district's primary customers from 1997 to 2004, before water conservation measures were put in place. The model is used to predict TRWD annual demands without conservation and allows for a comparison with actual demands. The difference between the model's projected demands and actual consumption is assumed to be savings.

Here are some highlights of the savings achieved from ongoing conservation efforts from 2007 through 2012:

- A cumulative savings of 72.29 billion gallons or 221,859 acre-feet.
- Annual savings ranging from 8.0 to 21.9 billion gallons, with savings on an annual basis averaging 12.0 billion gallons.
- An average savings of 33.0 mgd. At the 2012 rolling average consumption rate (180 gpcd), 33.0 mgd could supply an additional 183,300 people.
- An average savings of 36,977 acre-feet per year, which is 70 percent of the firm yield of the proposed Cedar Creek indirect reuse project.

Savings among the district's primary customers in 2012 alone was nearly 22 billion gallons – about 20 percent of the predicted demands without conservation. A chart illustrating the projected water demands versus actual demands and a table of the estimated annual savings is included below.

Table 1: Estimated Annual Savings Due to Ongoing Water Conservation Efforts and Drought Contingency Measures, 2007-2012

Year	Billion Gallons	Acre-Feet
2007	8.97	27,534
2008	7.95	24,395
2009	9.44	28,979
2010	9.65	29,612
2011	14.43	44,269
2012	21.86	67,070
Total Savings	**72.29**	**221,859**

Note: Some savings in 2011 and 2012 can be attributed to the implementation of Stage 1 drought contingency measures, which were in effect from August 29, 2011 through May 3, 2012. The Strategic Plan estimates Stage 1 drought measures lowered demands by an additional 5.76 billion gallons during that timeframe.

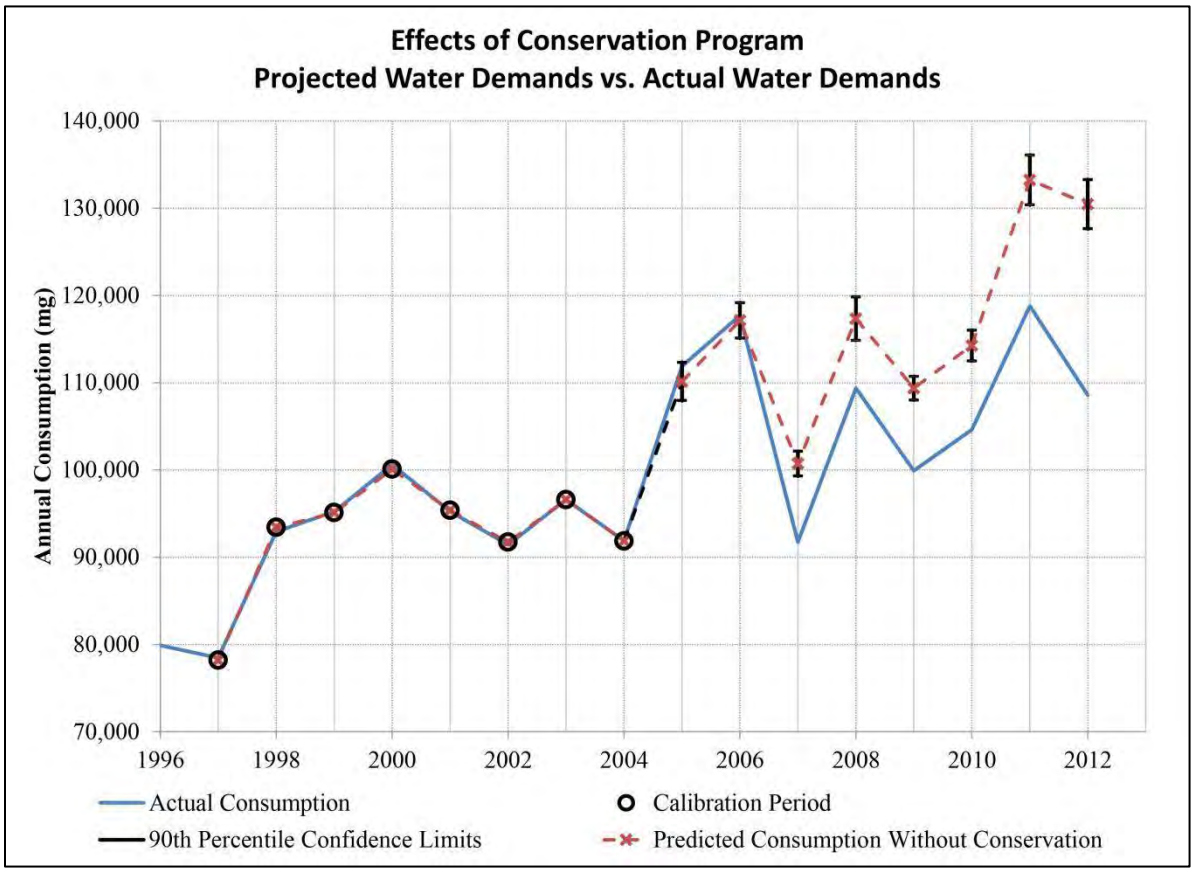

Figure 3: Estimated Consumption of TRWD's primary customers without Conservation Versus Actual Consumption

Projected Water Savings, Benefits, and Costs

Implementing all of the water conservation strategies over the next five years would nearly double the water savings achieved so far. The combined savings would amount to more than 63 mgd when compared to 2006 water use. By 2017, implementing the recommendations described above would produce the following water savings, benefits, and costs:[5]

- Annual water savings of 30.1 mgd, which is 56 percent greater than the conservation savings projected in the 2011 Region C Water Plan.
- Annual per capita water savings of 15.6 gpcd, putting TRWD on course to surpass its 2018 total water use goal of 166 gpcd.
- Cumulative present value benefits of about $30.9 million.
- Cumulative present value costs to utilities of about $14.4 million

Full implementation of all measures in the Plan would increase TRWD's water conservation budget from its current level of $1.89 million to $5.0 million annually by 2017. The projected annual water savings would be 33,700 acre-feet, enough to serve

the needs of an additional 180,000 people using existing supplies. The potential water savings through 2060 would be more than 2.84 million acre-feet. [6]

Saving water comes with economic benefits, as well. The potential economic benefit from all the evaluated water conservation measures has a present value of $8.0 to 10.0 million, and today's funding of water conservation measures will provide a substantial long-term return on the investment. The net present value of the potential long-term benefits from all evaluated measures through 2060 is projected to be $987.6 million.[7]

The other advantages of supporting a successful water conservation program include:[8]

- Extending the life of existing supplies and delaying the need for new water supplies.
- Reducing peak supply requirements and extending the life of existing infrastructure. Since water system infrastructure is sized to meet peak demands, reducing the peaks also delays the need to expand facilities.
- Positioning TRWD to obtain future water rights. To secure authorization of an interbasin transfer, the applicant must have "developed and implemented a water conservation plan that results in the highest practicable levels of water conservation…"[9]
- Positive environmental effects, improved customer good will, continued growth and economic development, and a reduction in TRWD's carbon footprint.

TRWD and Dallas Outreach Campaign

Since 2007, the water district has stepped up its commitment to water conservation and budgeted $9.49 million (through FY 2013) for its programs and staff support. Approximately $6.24 million or 66 percent of those funds were used to develop and promote a joint public outreach campaign with Dallas Water Utilities. The combined contribution from both entities for media outreach and production costs amounts to more than $2.0 million annually. By coordinating regional outreach to promote water conservation, TRWD doubles its advertising for the money spent.

The biggest focus of the water district's conservation efforts has been on reducing excessive outdoor water use. On an annual basis the four primary customers use 31 percent to 50 percent of their water for seasonal uses depending on climatic conditions.[10] In most years, outdoor water consumption exceeds 40 percent of total water demands. And studies have shown that overall homeowners over-water as much as 2-3 times the amount needed by plants, based on climate conditions. Changing outdoor irrigation habits and reducing excessive outdoor water use offers an opportunity to save tremendous amounts of water.

The investment in water conservation outreach and other programs is paying off. A simple comparison of the water savings and the water conservation budget from 2007 to 2012 indicates the unit cost of the savings to be $0.11 per thousand gallons.

Water Conservation as a Supply Strategy

Water supplies are not endless resources. The number of people living in our region is expected to nearly double in the next 50 years. That means the demand for water will rise – and meeting that demand in a sustainable way will be a challenge.

Conservation is a viable water supply strategy. It maximizes the use of current supplies to help meet the water needs of growing communities. And there are signs the water district's conservation efforts are increasing the efficient use of its water resources:

- In 2011, water consumption during the one-year drought of record among its primary customers increased less than 4,000 acre-feet compared to 2006, despite an increase in population of about 100,000 residents.
- In 2012, TRWD's primary customers used 67,000 acre-feet less than predicted based on climate conditions and a model of water use before water conservation measures were put in place.
- The savings in 2012 alone was slightly more than the firm yield of the Richland-Chambers indirect reuse project, which is 63,000 acre-feet.
- TRWD estimates the average water savings between 2007 through 2012 was 33.0 mgd. At today's consumption rate, 33.0 mgd could supply an additional 183,300 people with existing supplies.

When people use less water, it frees up more water (and energy) for us to accommodate the needs of more people. And the overall reduction in demands and lower peaking requirements should allow the water district to extend the horizon for developing new supplies.

The water district anticipates the savings to continue in the coming years. Since 2002, TRWD's average per capita water use has decreased more than eight percent. The declining trends in water consumption are not an accident. They are a combination of numerous influences, including the availability of more water efficient fixtures and appliances, pricing structures at the retail level, water utility leak detection and water loss programs, and an ongoing public education and outreach campaign.

The Tarrant Regional Water District embraces, and will continue to invest in, water conservation as a supply strategy. It's one of the most economical ways for TRWD to meet the needs of its customers. Using the water we have available today more efficiently means we will have more water to share with new residents, new businesses, and for future economic growth.

References

[1] Texas Water Development Board. 2011. Water for Texas: Summary of the 2011 Regional Water Plans. Retrieved August 1, 2013 from: http://www.twdb.state.tx.us/waterplanning/rwp/regions/doc/2011RWPLegislativeSummary.pdf

[2] Coomes, Paul, Tom Rockaway, Josh Rivard, Barry Kornstein, 2010. North America Residential Water Use Trends Since 1992, Water Research Foundation. Retrieved August 1, 2013 from: http://www.waterrf.org/PublicReportLibrary/4031.pdf.

[3] McDonald, Brian, Mike Mocek, 2013, January 16. Tarrant Regional Water District Strategic Water Conservation Plan, Alan Plummer Associates, Inc., Available from http://www.savetarrantwater.com/Pages/0307_043_01_final_report_v29%20trwd%20strategic%20plan.pdf.

[4] Ibid. p. 134

[5] Ibid. p. 133

[6] Ibid. p. 98

[7] Ibid. p. 103

[8] Ibid. p. 102

[9] Freese and Nichols, Inc. Alan Plummer Associates, Inc., CP&Y, Inc. and Cooksey Communications, Inc., 2011 Region C Water Plan: prepared for the Region C Water Planning Group, Fort Worth, October 2010.

[10] McDonald, Brian, Mike Mocek, 2013, January 16. Tarrant Regional Water District Strategic Water Conservation Plan, Alan Plummer Associates, Inc., Available from http://www.savetarrantwater.com/Pages/0307_043_01_final_report_v29%20trwd%20strategic%20plan.pdf. p. 41

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APPENDIX K

TARRANT REGIONAL WATER DISTRICT BOARD RESOLUTION ADOPTING THE WATER CONSERVATION AND DROUGHT CONTINGENCY PLAN

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Tarrant Regional Water District
Board Resolution Adopting the Water Conservation and Drought Contingency Plan

WHEREAS, Tarrant Regional Water District, a Water Control and Improvement District (the "District"), as a wholesale water supplier, is required by the Texas Commission on Environmental Quality to develop (a) a water conservation plan pursuant to Title 30, Part 1, Chapter 288, Subchapter A, Rule 288.5 of the Texas Administrative Code and (b) a drought contingency plan pursuant to Title 30, Part 1, Chapter 288, Subchapter B, Rule 288.22 of the Texas Administrative Code; and

WHEREAS, the District recognizes the importance of a long-term approach to conserving water supplies by reducing the volume of water withdrawn from its reservoirs, reducing the loss or waste of water, improving water use efficiency, and increasing the recycling and reuse of water; and

WHEREAS, the plan provides significant benefits to the District, its customers, and the public they serve through the implementation of year-round water saving strategies to increase District reservoir storage volumes during wet or dry weather conditions.

NOW, THEREFORE, be it resolved by the Board of Directors of the District that the Water Conservation and Drought Contingency Plan attached hereto as Exhibit A is adopted as the controlling policy of the District.

TARRANT REGIONAL WATER DISTRICT, a
Water Control and Improvement District

By: Victor W. Henderson

Victor W. Henderson
President, Board of Directors

ATTEST:

Martha V. Leonard

Martha V. Leonard
Secretary, Board of Directors

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APPENDIX L

LETTERS TO REGION C AND REGION D WATER PLANNING GROUPS

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APPENDIX L

Letters to Region C and Region D Water Planning Groups

Date

Mr. Jim Parks
Chair, Region C Water Planning Group
North Texas Municipal Water District
P.O. Box 2408
Wylie, TX 75098

Dear Mr. Parks:

Enclosed please find a copy of the recently adopted water conservation and drought contingency plan for the Tarrant Regional Water District. I am submitting a copy of this plan to the Region C Water Planning Group in accordance with the Texas Water Development Board and Texas Commission on Environmental Quality rules. The Board of the Tarrant Regional Water District adopted the attached plan on May 20, 2014.

Sincerely,

James M. Oliver
General Manager
Tarrant Regional Water District

Date

Mr. Bret McCoy
Chair, Region D Water Planning Group
C/O Northeast Texas Municipal Water District
P.O. Box 955
Hughes Springs, TX 75656

Dear Mr. McCoy:

Enclosed please find a copy of the recently adopted water conservation and drought contingency plan for the Tarrant Regional Water District. I am submitting a copy of this plan to the Region D Water Planning Group in accordance with the Texas Water Development Board and Texas Commission on Environmental Quality rules. The Board of the Tarrant Regional Water District adopted the attached plan on May 20, 2014.

Sincerely,

James M. Oliver
General Manager
Tarrant Regional Water District

APPENDIX M

RESULTS OF CLIMATIC MODELING STUDY BY HYDROSPHERE RESOURCE CONSULTANTS TO PREDICT IMPACTS ON TRWD WATER SUPPLIES AND PROJECTED WATER SAVINGS OF THE CONSERVATION AND DROUGHT CONTINGENCY PLAN

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APPENDIX M

Results of climatic modeling study by Hydrosphere Resource Consultants to predict impacts on TRWD water supplies and projected water savings of the water conservation and drought contingency plan

Background

Tarrant Regional Water District made a decision to review its current water conservation and drought contingency plan after experiencing one of the worst two-year droughts in North Texas history. The extended period of dry weather, which lasted from winter 2005 to spring 2007, offered TRWD an opportunity to observe the effectiveness of the current plan under severe drought conditions. The goal was to determine what effect the plan would have on extending water supplies for the 1.7 million people who ultimately rely on TRWD for their water.

The conclusions of an internal review of the current water conservation and drought contingency plan were disappointing. TRWD engineers determined that it had little effect on extending water supplies and that the plan made less than one percent (1%) difference in total storage volume of the TRWD reservoir system. The plan does not require the implementation of any mandatory water conserving measures until combined storage capacity in the TRWD reservoir system drops to 50%. After verifying the inadequate responses of the current plan, TRWD sought expert outside assistance to establish a realistic set of trigger points and responses that would significantly extend water supplies in times of drought.

The Study

Tarrant Regional Water District employed Hydrosphere Resource Consultants, an engineering firm in Boulder, Colorado, to evaluate the effectiveness of various water conservation and drought contingency strategies based on a series of simulated weather patterns. Hydrosphere examined hundreds of climatic scenarios to predict their impact on reservoir volumes within the TRWD system; to compare water savings of drought contingency plans at selected trigger points; and to determine the frequency that reservoir storage volumes would reach the drought stage triggers.

Hydrosphere based its statistical analysis of the effects of weather patterns on reservoir levels using the Monte Carlo method. The simulated climatic conditions randomly generated by the Monte Carlo technique were based on existing North Texas weather patterns from 1940 to 2002. Each weather pattern was classified as average, dry, or drought, with wet years included in the average group. The weather patterns consisted of rainfall and evaporation data. The climatic modeling was based on the cycle of average, dry, and drought years experienced over the 43-year period. The analyses produced robust estimates of reservoir volumes, the frequency of their occurrence, and the water savings that would be achieved by implementing drought stages based on reservoir capacities of 75, 60, and 45 percent.

The projected water savings is based on a reduction in water use achieved through the implementation of outdoor watering restrictions at each stage of the new water conservation and drought contingency plan. Here is a recap of the restrictions by drought stage:

- At 75% capacity (Stage 1, Water Watch) landscape watering would be reduced to twice per week.
- At 60% capacity (Stage 2, Water Warning) landscape watering would be reduced to once per week.
- At 45% capacity (Stage 3, Emergency Water Use) landscape watering would be banned.

The model produced by the Hydrosphere study assumed that demands would decrease by 10% under the twice per week outdoor watering schedule; consumption would drop an additional 10% with once per week watering; and that no outdoor watering would result in another 20% reduction in demands.

Study Results: Estimated Savings of the New Plan

The table below depicts the estimated savings that would be achieved once the trigger points are reached and the drought stages are activated. The volume of water saved is based on anticipated demands in 2010 and 2020, which are expected to average 29,000 and 35,000 acre-feet per month, respectively.

Estimated Savings at Selected Trigger Points of Proposed Water Conservation and Drought Contingency Plan (in acre-feet)

Drought Stage	Percent conservation storage	2010 demands	2020 demands
Stage 1, Water Watch	Supply = 75%	2,035	1,973
Stage 2, Water Warning	Supply = 60%	22,388	30,448
Stage 3, Emergency Water Use	Supply = 45%	43,788	58,548

- The estimated savings at each drought stage represents an increase in the amount of water available in the TRWD reservoir system under the new water conservation and drought contingency plan versus having no plan in place.
- When compared to the plan currently in effect, implementing the new plan would stretch available water supplies by almost two months under Stage 3 drought conditions. The savings is even more dramatic when both plans are compared under the worst anticipated drought conditions.
-

Study Results: Comparison of Current and New Plans Under Severe Drought Conditions

Under the current water conservation and drought contingency plan, once a week watering restrictions are not required until storage in the TRWD reservoir system reaches 50% maximum capacity; and outdoor watering is not banned until reservoirs bottom out at 25% maximum capacity. The table below compares the water savings that would be achieved by the current versus the new plan under the worst simulated drought conditions over a seven-year period.

Comparison of Water Savings (in acre-feet) Between the Current and New Water Conservation and Drought Contingency Plans Based on 2010 and 2020 Demands		
Year	Current Plan (Triggers = 50 and 25%)	New Plan (Triggers = 75, 60, 45%)
2010	18,300	62,600
2020	22,000	98,500

- In the case of a severe drought, implementing the new water conservation and drought contingency plan will increase water supplies by a projected three to four times the amount that would have been available under the current plan.
- The water savings achieved by the current plan represents less than a one month supply of the demands anticipated in 2010 and 2020.

Study Results: Probability of Reaching Trigger Points with the New Water Conservation and Drought Contingency Plan in Effect

The table below shows the probability of reaching the combined TRWD reservoir storage capacities of 75%, 60%, and 45%.

Frequency or probability of combined TRWD reservoir storage capacities			
Drought Stage	Percent conservation storage	2010 demands	2020 demands
Stage 1, Water Watch	Supply = 75%	20%	26%
Stage 2, Water Warning	Supply = 60%	4%	6%
State 3, Emergency Water Use	Supply = 45%	0.3%	0.6%

- The Hydrosphere study concluded that the Stage 1 drought conditions would prevail roughly 20% of the time (or about once every five years) in 2010, and roughly 26% of the time (or an average of about once every four years) in 2020.

- Stage 2 drought conditions and the implementation of mandatory once a week outdoor watering restrictions would take place approximately once every 25 and 17 years, based on demands in 2010 and 2020, respectively.

- The odds of implementing the outdoor watering ban, which goes into effect with Stage 3 drought conditions, are once every 333 and 167 years, based on demands in 2010 and 2020, respectively.

Conclusion

Revising the current water conservation and drought contingency plan is necessary in order to achieve meaningful increases in TRWD reservoir storage volumes during extended periods of dry weather. Studies have shown that outdoor residential water use, especially in hot dry areas like Texas, can account for up to 50% or more of the total volume of water consumed annually per household. By establishing new trigger points before reservoirs drop to critical levels of 50% or less, TRWD and its customers are taking a proactive approach to preserving water supplies.

The outdoor watering restrictions called for in the first two stages of the new water conservation and drought contingency plan (reservoir storage capacities of 75 and 60 percent) should have a negligible impact on residential landscapes. They simply require residents to be more efficient in their outdoor water use. The ban on outdoor watering during a Stage 3 drought will likely have an impact on a majority of landscapes, especially during the summer, however landscapes with drought-tolerant plants will survive. More importantly, the plan will help maintain adequate water supplies for domestic water, sanitation, and fire protection needs in a manner that protects and preserves public health, welfare and safety.

In light of the projected increases in the North Texas population, there is a need to ensure water supplies will meet community needs not only during severe droughts, but over the long-term. The conservation lifestyle is not a choice anymore. It is an essential component of a paradigm shift in water use that will allow TRWD and its customers to achieve the goals set forth in the new water conservation and drought contingency plan:

- To conserve the available water supply in times of drought and emergency
- To minimize the adverse impacts of water supply shortages
- To reduce water consumption from the levels that would prevail without conservation efforts.
- To reduce the loss and waste of water.
- To improve efficiency in the use of water.

APPENDIX N

TEXAS WATER CODE SECTION 11.039

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APPENDIX N

Texas Water Code Section 11.039

§ 11.039. Distribution of Water During Shortage

(a) If a shortage of water in a water supply not covered by a water conservation plan prepared in compliance with Texas Natural Resource Conservation Commission or Texas Water Development Board rules results from drought, accident, or other cause, the water to be distributed shall be divided among all customers pro rata, according to the amount each may be entitled to, so that preference is given to no one and everyone suffers alike.

(b) If a shortage of water in a water supply covered by a water conservation plan prepared in compliance with Texas Natural Resource Conservation Commission or Texas Water Development Board rules results from drought, accident, or other cause, the person, association of persons, or corporation owning or controlling the water shall divide the water to be distributed among all customers pro rata, according to:

(1) the amount of water to which each customer may be entitled; or

(2) the amount of water to which each customer may be entitled, less the amount of water the customer would have saved if the customer had operated its water system in compliance with the water conservation plan.

(c) Nothing in Subsection (a) or (b) precludes the person, association of persons, or corporation owning or controlling the water from supplying water to a person who has a prior vested right to the water under the laws of this state.

Amended by Acts 1977, 65th Leg., p. 2207, ch. 870, § 1, eff. Sept. 1, 1977.

Amended by Acts 2001, 77th Leg., ch. 1126, § 1, eff. June 15, 2001.

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TRWD Part C #45 d

	PROJECTED 2016	PROJECTED 2017	PROJECTED 2018	PROJECTED 2019	PROJECTED 2020	PROJECTED 2021	PROJECTED 2022	PROJECTED 2023	PROJECTED 2024	PROJECTED 2025	PROJECTED 2026	PROJECTED 2027	PROJECTED 2028	PROJECTED 2029	PROJECTED 2030	PROJECTED 2031
SYSTEM OPERATIONS																
Operations and Maintenance	39,079,343	41,424,104	46,209,550	48,982,123	58,921,050	62,456,313	66,203,692	70,175,913	74,386,468	78,849,656	83,580,636	88,595,474	93,911,202	99,545,874	105,518,627	111,849,745
Pumping Power (53)	23,500,000	24,205,000	24,931,150	25,679,085	26,449,457	27,242,941	28,060,229	28,902,036	29,769,097	30,662,170	31,582,035	32,529,496	33,505,381	34,510,542	35,545,859	36,612,234
Capital Expenditures (5%)	1,333,500	1,500,000	1,575,000	1,653,750	1,736,438	1,823,259	1,914,422	2,010,143	2,110,651	2,216,183	2,326,992	2,443,342	2,565,509	2,693,784	2,828,474	2,969,897
TOTAL EXPENSES	63,912,843	67,129,104	72,715,700	76,314,957	87,106,945	91,522,513	96,178,343	101,088,093	106,266,216	111,728,009	117,489,663	123,568,312	129,982,092	136,750,201	143,892,959	151,431,876
OUTSTANDING BOND DEBT SERVICE																
TRWD OUTSTANDING PRINCIPAL & INTEREST	71,742,914	71,169,384	63,521,162	64,446,229	64,996,969	64,410,912	64,750,821	62,498,919	60,055,852	57,912,989	57,917,489	57,917,489	57,917,489	57,917,489	57,917,489	57,917,489
DWU Contract Revenue Bonds	21,141,006	21,024,556	20,900,506	20,778,556	20,652,806	20,512,706	20,383,206	20,252,906	20,210,956	20,162,306	20,115,206	20,171,406	20,260,206	20,363,556	20,410,106	20,456,406
BOND PAYING AGENT FEES	3,850	3,350	3,350	3,350	3,350	3,350	3,350	3,350	3,350	3,350	3,350	3,350	3,350	3,350	3,350	3,350
TOTAL OUTSTANDING BOND DEBT SERVICE	92,887,770	92,197,290	84,425,018	85,228,135	85,653,125	84,926,968	85,137,377	82,755,175	80,270,158	78,078,645	78,036,045	78,092,245	78,181,045	78,284,395	78,330,945	78,377,245
PROPOSED BOND DEBT SERVICE																
2016 Issue for IPL-$300 mil	7,472,295	16,092,605	16,092,921	16,093,911	16,094,411	16,090,532	16,092,174	16,093,545	16,094,144	16,091,015	16,089,833	16,091,047	16,091,728	16,093,074	16,091,747	16,093,823
2016 other projects	972,641	2,378,644	2,382,769	2,380,313	2,381,275	2,380,513	2,378,025	2,378,669	2,382,156	2,378,488	2,382,519	2,379,106	2,378,250	2,379,663	2,378,200	2,378,719
2016 DWU Contract Revenue Bonds	3,468,208	7,549,781	7,551,752	7,550,954	7,553,356	7,549,465	7,553,861	7,551,317	7,551,871	7,550,425	7,553,406	7,550,587	7,553,321	7,552,037	7,553,101	7,551,457
2018 Issue for IPL-$195 mil and 20 mil for other projects	0	0	7,883,333	14,635,525	14,632,175	14,634,613	14,632,288	14,634,650	14,636,013	14,635,825	14,633,538	14,633,463	14,634,775	14,636,650	14,633,400	14,634,200
2018 DWU Contract Revenue Bonds	0	0	3,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000
BOND PAYING AGENT FEES	700	700	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050
TOTAL PROPOSED BOND DEBT SERVICE	11,913,844	26,021,730	36,911,825	45,661,753	45,662,267	45,656,173	45,657,398	45,659,231	45,665,234	45,656,803	45,660,346	45,655,253	45,659,124	45,662,474	45,657,498	45,659,249
SUBTOTAL DEBT SERVICE	104,801,614	118,219,020	121,336,843	130,889,888	131,315,392	130,583,141	130,794,775	128,414,406	125,935,392	123,735,448	123,696,391	123,747,498	123,840,169	123,946,869	123,988,443	124,036,494
TOTAL EXPENDITURES	168,714,457	185,348,124	194,052,543	207,204,845	218,422,337	222,105,654	226,973,118	229,502,499	232,201,608	235,463,457	241,186,054	247,315,810	253,822,261	260,697,070	267,881,402	275,468,370
OTHER INCOME																
WATER SALES NOT UNDER SYSTEM RATE	1,400,000	1,470,000	1,484,700	1,499,547	1,514,542	1,529,688	1,544,985	1,560,435	1,576,039	1,591,799	1,607,717	1,623,795	1,640,032	1,656,433	1,672,997	1,689,727
INTEREST EARNED	2,000,000	2,500,000	2,388,000	2,750,000	2,475,000	2,300,000	2,225,000	2,230,000	2,192,000	3,352,000	3,048,000	3,048,000	3,048,000	3,048,000	3,048,000	3,048,000
Sale of system capacity (DWU Contract Revenue Bonds)	24,609,214	28,574,337	31,452,258	33,329,510	33,206,162	33,062,171	32,937,067	32,804,223	32,762,827	32,712,731	32,668,612	32,721,993	32,813,527	32,915,593	32,963,207	33,007,863
Other Revenues	1,085,500	1,096,355	1,107,319	1,118,392	1,129,576	1,140,871	1,152,280	1,163,803	1,175,441	1,187,195	1,199,067	1,211,058	1,223,169	1,235,400	1,247,754	1,260,232
TOTAL OTHER INCOME	29,094,714	33,640,692	36,432,277	38,697,449	38,325,280	38,032,730	37,859,332	37,758,461	37,706,307	38,843,726	38,523,397	38,604,846	38,724,728	38,855,426	38,931,958	39,005,822
NET SYSTEM REQUIREMENTS	139,619,743	151,707,432	157,620,266	168,507,397	180,097,057	184,072,924	189,113,786	191,744,038	194,495,301	196,619,732	202,662,657	208,710,964	215,097,533	221,841,644	228,949,444	236,462,548

SYSTEM WATER RATES	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
5 yr customer demands projections then 1.00% after that (1st 2021)																
FORT WORTH (IN-DISTRICT)	48,600,000	48,850,000	49,100,000	49,350,000	49,650,000	50,146,500	50,647,965	51,154,445	51,665,989	52,182,649	52,704,475	53,231,520	53,763,835	54,301,474	54,844,489	55,392,933
FORT WORTH (OUT-DISTRICT)	20,844,000	20,950,000	21,050,000	21,150,000	21,250,000	21,462,500	21,677,125	21,893,896	22,112,835	22,333,964	22,557,303	22,782,876	23,010,705	23,240,812	23,473,220	23,707,952
ARLINGTON	19,201,194	20,370,546	20,370,546	20,370,546	20,370,546	20,574,251	20,779,994	20,987,794	21,197,672	21,409,649	21,623,745	21,839,983	22,058,382	22,278,966	22,501,756	22,726,773
TRINITY RIVER AUTHORITY	12,410,883	12,363,165	12,454,043	12,548,943	12,672,747	12,799,474	12,927,469	13,056,744	13,187,311	13,319,184	13,452,376	13,586,900	13,722,769	13,859,997	13,998,597	14,138,583
MANSFIELD	4,461,479	4,487,222	4,505,346	4,533,116	4,578,447	4,624,232	4,670,474	4,717,179	4,764,350	4,811,994	4,860,114	4,908,715	4,957,802	5,007,380	5,057,454	5,108,029
OTHER (IN-DISTRICT)	1,000,000	1,010,000	1,020,100	1,030,301	1,040,604	1,051,010	1,061,520	1,072,135	1,082,857	1,093,685	1,104,622	1,115,668	1,126,825	1,138,093	1,149,474	1,160,969
OTHER (OUT-DISTRICT)	10,000,000	10,100,000	10,201,000	10,303,010	10,406,040	10,510,101	10,615,202	10,721,354	10,828,567	10,936,853	11,046,221	11,156,683	11,268,250	11,380,933	11,494,742	11,609,690
TOTAL	116,517,556	118,130,933	118,701,035	119,285,916	119,968,384	121,168,068	122,379,749	123,603,546	124,839,582	126,087,978	127,348,857	128,622,346	129,908,569	131,207,655	132,519,732	133,844,929
PROJECTED SYSTEM WATER RATES ($/1000 GAL.)																
FORT WORTH (IN-DISTRICT)	1.19225	1.27972	1.32488	1.41116	1.50120	1.51915	1.54530	1.55128	1.55796	1.55939	1.59140	1.62266	1.65576	1.69077	1.72766	1.76669
FORT WORTH (OUT-DISTRICT)	1.20425	1.28872	1.33088	1.41416	1.50120	1.51915	1.54530	1.55128	1.55796	1.55939	1.59140	1.62266	1.65576	1.69077	1.72766	1.76669
ARLINGTON	1.19900	1.28472	1.32813	1.41266	1.50120	1.51915	1.54530	1.55128	1.55796	1.55939	1.59140	1.62266	1.65576	1.69077	1.72766	1.76669
TRINITY RIVER AUTHORITY	1.20425	1.28872	1.33088	1.41416	1.50120	1.51915	1.54530	1.55128	1.55796	1.55939	1.59140	1.62266	1.65576	1.69077	1.72766	1.76669
MANSFIELD	1.20425	1.28872	1.33088	1.41416	1.50120	1.51915	1.54530	1.55128	1.55796	1.55939	1.59140	1.62266	1.65576	1.69077	1.72766	1.76669
OTHER (IN-DISTRICT)	1.19225	1.27972	1.32488	1.41116	1.50120	1.51915	1.54530	1.55128	1.55796	1.55939	1.59140	1.62266	1.65576	1.69077	1.72766	1.76669
OTHER (OUT-DISTRICT)	1.20425	1.28872	1.33088	1.41416	1.50120	1.51915	1.54530	1.55128	1.55796	1.55939	1.59140	1.62266	1.65576	1.69077	1.72766	1.76669
PROJECTED SYSTEM REVENUE: ($)																
FORT WORTH (IN-DISTRICT)	57,943,134	62,514,305	65,051,679	69,640,631	74,534,794	76,180,243	78,266,450	79,355,003	80,493,638	81,372,853	83,873,772	86,376,919	89,020,058	91,811,169	94,752,796	97,862,163
FORT WORTH (OUT-DISTRICT)	25,101,294	26,998,677	28,015,055	29,909,435	31,900,592	32,604,837	33,497,725	33,963,622	34,450,953	34,827,253	35,897,637	36,968,973	38,100,226	39,294,811	40,553,815	41,884,611
ARLINGTON	23,022,146	26,170,441	27,054,763	28,776,608	30,580,352	31,255,451	32,111,386	32,558,001	33,025,163	33,385,890	34,411,975	35,438,973	36,523,408	37,668,553	38,875,452	40,151,172
TRINITY RIVER AUTHORITY	14,945,751	15,932,654	16,574,855	17,746,184	19,024,383	19,444,370	19,976,856	20,254,700	20,545,327	20,769,740	21,408,078	22,046,986	22,721,625	23,434,033	24,184,858	24,978,498
MANSFIELD	5,372,716	5,782,771	5,996,081	6,410,541	6,873,185	7,024,919	7,217,297	7,317,678	7,422,676	7,503,752	7,734,373	7,965,200	8,208,935	8,466,316	8,737,576	9,024,305
OTHER (IN-DISTRICT)	1,192,246	1,292,517	1,351,512	1,453,917	1,562,159	1,596,646	1,640,370	1,663,185	1,687,049	1,705,477	1,757,893	1,810,356	1,865,753	1,924,251	1,985,904	2,051,073
OTHER (OUT-DISTRICT)	12,042,456	13,016,068	13,576,322	14,570,081	15,621,592	15,966,458	16,403,702	16,631,850	16,870,494	17,054,767	17,578,929	18,103,559	18,657,529	19,242,512	19,859,041	20,510,727
TOTAL	139,619,743	151,707,432	157,620,266	168,507,397	180,097,057	184,072,924	189,113,786	191,744,038	194,495,301	196,619,732	202,662,657	208,710,964	215,097,533	221,841,644	228,949,444	236,462,548

	PROJECTED 2032	PROJECTED 2033	PROJECTED 2034	PROJECTED 2035	PROJECTED 2036	PROJECTED 2037	PROJECTED 2038	PROJECTED 2039	PROJECTED 2040	PROJECTED 2041	PROJECTED 2042	PROJECTED 2043	PROJECTED 2044	PROJECTED 2045	PROJECTED 2046
SYSTEM OPERATIONS															
Operations and Maintenance	118,560,729	125,674,373	133,214,835	141,207,725	149,680,189	158,661,000	168,180,660	178,271,500	188,967,790	200,305,857	212,324,209	225,063,661	238,567,481	252,881,530	268,054,422
Pumping Power (53)	37,710,601	38,841,919	40,007,177	41,207,392	42,443,614	43,716,922	45,028,430	46,379,283	47,770,662	49,203,781	50,679,895	52,200,292	53,766,300	55,379,289	57,040,668
Capital Expenditures (5%)	3,118,392	3,274,312	3,438,027	3,609,929	3,790,425	3,979,947	4,178,944	4,387,891	4,607,286	4,837,650	5,079,532	5,333,509	5,600,184	5,880,194	6,174,203
TOTAL EXPENSES	159,389,723	167,790,604	176,660,040	186,025,047	195,914,228	206,357,869	217,388,034	229,038,674	241,345,737	254,347,289	268,083,636	282,597,462	297,933,966	314,141,013	331,269,293
OUTSTANDING BOND DEBT SERVICE															
TRWD OUTSTANDING PRINCIPAL & INTEREST	57,917,489	57,917,489	57,917,489	57,917,489	57,917,489	57,917,489	57,917,489	57,917,489	57,917,489	57,917,489	57,917,489	57,917,489	57,917,489	57,917,489	57,917,489
DWU Contract Revenue Bonds	20,500,812	20,495,862	20,556,062	20,607,562	20,664,412	20,725,062	20,787,862	20,776,212	20,761,512	20,747,312	20,736,962	13,053,562	13,057,312	0	0
BOND PAYING AGENT FEES	3,350	3,350	3,350	3,350	3,350	3,350	3,350	3,350	3,350	3,350	3,350	3,350	3,350	3,350	3,350
TOTAL OUTSTANDING BOND DEBT SERVICE	78,421,651	78,416,701	78,476,901	78,528,401	78,585,251	78,645,901	78,708,701	78,697,051	78,682,351	78,668,151	78,657,801	70,974,401	70,978,151	57,920,839	57,920,839
PROPOSED BOND DEBT SERVICE															
2016 Issue for IPL-$300 mil	16,094,425	16,093,884	16,092,361	16,094,431	16,089,757	16,094,381	16,094,270	16,093,986	16,093,002	16,090,950	16,091,867	16,089,626	16,093,514	16,092,814	0
2016 other projects	2,380,931	2,379,694	2,379,863	2,381,150	2,378,413	2,381,363	2,379,713	2,378,319	2,381,750	2,379,719	2,381,938	2,378,119	2,377,975	2,380,931	2,381,556
2016 DWU Contract Revenue Bonds	7,552,404	7,550,755	7,551,985	7,550,869	7,552,208	7,551,095	7,553,541	7,554,196	7,552,888	7,549,441	7,554,181	7,550,749	7,549,145	7,549,014	
2018 Issue for IPL-$195 mil and 20 mil for other projects	14,633,088	14,634,100	14,636,138	14,633,238	14,634,300	14,633,088	14,633,363	14,633,750	14,632,875	14,634,225	14,636,150	14,637,000	14,635,125	14,633,738	14,635,775
2018 DWU Contract Revenue Bonds	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000
BOND PAYING AGENT FEES	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050
TOTAL PROPOSED BOND DEBT SERVICE	45,661,898	45,659,483	45,661,397	45,660,738	45,655,728	45,660,977	45,661,937	45,661,301	45,661,565	45,655,385	45,665,186	45,656,544	45,656,809	45,657,547	22,018,381
SUBTOTAL DEBT SERVICE	124,083,549	124,076,184	124,138,298	124,189,139	124,240,979	124,306,878	124,370,638	124,358,352	124,343,916	124,323,536	124,322,987	116,630,945	116,634,960	103,578,386	79,939,220
TOTAL EXPENDITURES	283,473,272	291,866,788	300,798,338	310,214,186	320,155,207	330,664,747	341,758,672	353,397,026	365,689,653	378,670,825	392,406,623	399,228,407	414,568,926	417,719,399	411,208,513
OTHER INCOME															
WATER SALES NOT UNDER SYSTEM RATE	1,706,624	1,723,691	1,740,928	1,758,337	1,775,920	1,793,679	1,811,616	1,829,732	1,848,030	1,866,510	1,885,175	1,904,027	1,923,067	1,942,298	1,961,721
INTEREST EARNED	3,048,000	3,048,000	3,048,000	3,048,000	3,048,000	3,048,000	3,048,000	3,048,000	3,048,000	3,048,000	3,048,000	3,048,000	3,048,000	3,048,000	3,048,000
Sale of system capacity (DWU Contract Revenue Bonds)	33,053,216	33,046,617	33,108,047	33,158,431	33,216,620	33,276,157	33,341,403	33,330,408	33,314,400	33,296,753	33,291,143	25,604,311	25,606,457	12,549,014	5,000,000
Other Revenues	1,272,834	1,285,562	1,298,418	1,311,402	1,324,516	1,337,761	1,351,139	1,364,650	1,378,297	1,392,080	1,406,001	1,420,061	1,434,261	1,448,604	1,463,090
TOTAL OTHER INCOME	39,080,674	39,103,870	39,195,393	39,276,170	39,365,056	39,455,598	39,552,158	39,572,791	39,588,727	39,603,343	39,630,319	31,976,399	32,011,785	18,987,916	11,472,811
NET SYSTEM REQUIREMENTS	244,392,597	252,762,918	261,602,945	270,938,016	280,790,151	291,209,150	302,206,514	313,824,235	326,100,927	339,067,482	352,776,304	367,252,009	382,557,141	398,731,483	399,735,702

SYSTEM WATER RATES	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046
PROJECTED WATER USE (1000 GAL.)															
5 yr customer demands projections then 1.00% after that (1s															
FORT WORTH (IN-DISTRICT)	55,946,863	56,506,331	57,071,395	57,642,109	58,218,530	58,800,715	59,388,722	59,982,609	60,582,435	61,188,260	61,800,142	62,418,144	63,042,325	63,672,749	64,309,476
FORT WORTH (OUT-DISTRICT)	23,945,032	24,184,482	24,426,327	24,670,590	24,917,296	25,166,469	25,418,134	25,672,315	25,929,038	26,188,329	26,450,212	26,714,714	26,981,861	27,251,680	27,524,197
ARLINGTON	22,954,041	23,183,582	23,415,417	23,649,572	23,886,067	24,124,928	24,366,177	24,609,839	24,855,937	25,104,497	25,355,542	25,609,097	25,865,188	26,123,840	26,385,078
TRINITY RIVER AUTHORITY	14,279,969	14,422,768	14,566,996	14,712,666	14,859,793	15,008,390	15,158,474	15,310,059	15,463,160	15,617,791	15,773,969	15,931,709	16,091,026	16,251,936	16,414,456
MANSFIELD	5,159,109	5,210,700	5,262,807	5,315,435	5,368,589	5,422,275	5,476,498	5,531,263	5,586,576	5,642,441	5,698,866	5,755,854	5,813,413	5,871,547	5,930,263
OTHER (IN-DISTRICT)	1,172,579	1,184,304	1,196,147	1,208,109	1,220,190	1,232,392	1,244,716	1,257,163	1,269,735	1,282,432	1,295,256	1,308,209	1,321,291	1,334,504	1,347,849
OTHER (OUT-DISTRICT)	11,725,786	11,843,044	11,961,475	12,081,090	12,201,900	12,323,919	12,447,159	12,571,630	12,697,346	12,824,320	12,952,563	13,082,089	13,212,910	13,345,039	13,478,489
TOTAL	135,183,378	136,535,212	137,900,564	139,279,570	140,672,365	142,079,089	143,499,880	144,934,879	146,384,228	147,848,070	149,326,551	150,819,816	152,328,014	153,851,294	155,389,807
PROJECTED SYSTEM WATER RATES ($/1000 GAL.)															
FORT WORTH (IN-DISTRICT)	1.80786	1.85127	1.89704	1.94528	1.99606	2.04963	2.10597	2.16528	2.22771	2.29335	2.36245	2.43504	2.51140	2.59167	2.57247
FORT WORTH (OUT-DISTRICT)	1.80786	1.85127	1.89704	1.94528	1.99606	2.04963	2.10597	2.16528	2.22771	2.29335	2.36245	2.43504	2.51140	2.59167	2.57247
ARLINGTON	1.80786	1.85127	1.89704	1.94528	1.99606	2.04963	2.10597	2.16528	2.22771	2.29335	2.36245	2.43504	2.51140	2.59167	2.57247
TRINITY RIVER AUTHORITY	1.80786	1.85127	1.89704	1.94528	1.99606	2.04963	2.10597	2.16528	2.22771	2.29335	2.36245	2.43504	2.51140	2.59167	2.57247
MANSFIELD	1.80786	1.85127	1.89704	1.94528	1.99606	2.04963	2.10597	2.16528	2.22771	2.29335	2.36245	2.43504	2.51140	2.59167	2.57247
OTHER (IN-DISTRICT)	1.80786	1.85127	1.89704	1.94528	1.99606	2.04963	2.10597	2.16528	2.22771	2.29335	2.36245	2.43504	2.51140	2.59167	2.57247
OTHER (OUT-DISTRICT)	1.80786	1.85127	1.89704	1.94528	1.99606	2.04963	2.10597	2.16528	2.22771	2.29335	2.36245	2.43504	2.51140	2.59167	2.57247
PROJECTED SYSTEM REVENUE: ($)															
FORT WORTH (IN-DISTRICT)	101,144,085	104,608,218	108,266,743	112,130,146	116,207,541	120,519,538	125,070,897	129,878,996	134,959,815	140,326,142	145,999,662	151,990,563	158,324,730	165,018,628	165,434,233
FORT WORTH (OUT-DISTRICT)	43,289,261	44,771,896	46,337,730	47,991,251	49,736,360	51,581,877	53,529,840	55,587,687	57,762,257	60,059,023	62,487,267	65,051,349	67,762,347	70,627,308	70,805,185
ARLINGTON	41,497,689	42,918,963	44,419,993	46,005,082	47,677,967	49,447,106	51,314,450	53,287,131	55,371,705	57,573,416	59,901,165	62,359,129	64,957,929	67,704,321	67,874,837
TRINITY RIVER AUTHORITY	25,816,181	26,700,372	27,634,180	28,620,281	29,661,002	30,761,604	31,923,300	33,150,527	34,447,363	35,817,073	37,265,192	38,794,319	40,411,062	42,119,624	42,225,704
MANSFIELD	9,326,946	9,646,389	9,983,758	10,340,019	10,716,014	11,113,642	11,533,343	11,976,719	12,445,244	12,940,097	13,463,278	14,015,725	14,599,827	15,217,101	15,255,426
OTHER (IN-DISTRICT)	2,119,858	2,192,462	2,269,140	2,350,112	2,435,570	2,525,944	2,621,335	2,722,107	2,828,595	2,941,066	3,059,977	3,185,539	3,318,295	3,458,591	3,467,302
OTHER (OUT-DISTRICT)	21,198,578	21,924,619	22,691,401	23,501,124	24,355,697	25,259,439	26,213,349	27,221,068	28,285,947	29,410,664	30,599,765	31,855,385	33,182,950	34,585,911	34,673,016
TOTAL	244,392,597	252,762,918	261,602,945	270,938,016	280,790,151	291,209,150	302,206,514	313,824,235	326,100,927	339,067,482	352,776,304	367,252,009	382,557,141	398,731,483	399,735,702

TARRANT REGIONAL WATER DISTRICT - Part C #46
Five year comparative system Operating Statement
STATEMENT OF REVENUES, EXPENSES, AND CHANGES IN NET POSITION—ENTERPRISE FUND

	UnAudited - 2nd Quarter	Audited				
	2015	2014	2013	2012	2011	2010
OPERATING REVENUES:						
Sale of water	$ 63,518,545	$ 121,710,988	$ 112,139,871	$ 98,844,939	$ 90,310,650	$ 79,465,525
Sale of system capacity	10,610,903	14,072,987	7,903,394	-	-	-
Land lease rentals	26,710	88,640	85,681	76,624	79,586	78,480
Sale of Power	9,912	-	-	-	-	-
Other	755,945	942,094	1,081,368	594,205	1,439,863	940,119
Total operating revenues	74,922,015	136,814,709	121,210,314	99,515,768	91,830,099	80,484,124
OPERATING EXPENSES:						
General and administrative	8,600,239	27,693,314	20,932,405	17,361,268	14,737,095	12,375,073
Personnel services	5,597,063	11,136,074	10,235,724	9,690,663	10,501,881	10,525,135
Utilities	11,094,862	29,499,922	23,328,536	17,996,090	15,108,701	10,173,954
Depreciation and amortization	-	16,428,450	16,573,425	16,656,082	16,174,207	15,663,973
Pension plan contribution	616,586	1,223,685	1,156,824	1,078,990	1,093,831	673,986
Total operating expenses	25,908,750	85,981,445	72,226,914	62,783,093	57,615,715	49,412,121
OPERATING INCOME	49,013,265	50,833,264	48,983,400	36,732,675	34,214,384	31,072,003
NONOPERATING INCOME (EXPENSE):						
Investment income	2,321,258	1,598,019	262,520	2,183,834	1,873,044	2,969,407
Interest expense	(30,019,730)	(18,920,099)	(14,938,583)	(19,238,227)	(19,140,654)	(19,714,313)
Gain on disposal of capital assets	27,243	43,508	48,310	56,343	72,296	67,958
Total nonoperating income (expense)	(27,671,229)	(17,278,572)	(14,627,753)	(16,998,050)	(17,195,314)	(16,676,948)
NET INCOME	21,342,036	33,554,692	34,355,647	19,734,625	17,019,070	14,395,055
NET POSITION----Beginning of year	371,867,216	338,312,524	312,220,780	292,486,155	275,372,007	260,976,952
Change in accounting principle due to implementation of GASB 65	-	-	(8,263,903)	-	-	-
Net Position ---Beginning of year adjusted	371,867,216	338,312,524	303,956,877	292,486,155	275,372,007	260,976,952
NET POSITION—End of year	$ 393,209,252	$ 371,867,216	$ 338,312,524	$ 312,220,780	$ 292,391,077	$ 275,372,007

Trec 3

Part C #46

Tarrant Regional Water District

Report to Management for the
Year Ended September 30, 2014

Deloitte.

Deloitte & Touche LLP
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January 9, 2015

Board of Directors of Tarrant Regional Water District
Fort Worth, Texas

The Management of Tarrant Regional Water District
Fort Worth, Texas

Dear Members of the Board of Directors and Management:

In planning and performing our audit of the financial statements of Tarrant Regional Water District (the "District") as of and for the year ended September 30, 2014 (on which we have issued our report dated January 9, 2015), in accordance with auditing standards generally accepted in the United States of America, we considered the District's internal control over financial reporting as a basis for designing audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on the effectiveness of the District's internal control over financial reporting. Accordingly, we do not express an opinion on the effectiveness of the District's internal control over financial reporting.

Our consideration of internal control over financial reporting was for the limited purpose described in the preceding paragraph and was not designed to identify all deficiencies in internal control over financial reporting that might be significant deficiencies or material weaknesses and therefore, material weaknesses or significant deficiencies may exist that were not identified. We did not identify any deficiencies in internal control over financial reporting that we consider to be material weaknesses.

We have identified, and included in the attached Appendix, other matters as of September 30, 2014 that we wish to bring to your attention.

The definitions of a deficiency and a material weakness are also set forth in the attached Appendix.

A description of the responsibility of management for establishing and maintaining internal control over financial reporting and of the objectives of and inherent limitations of internal control over financial reporting, is set forth in the attached Appendix and should be read in conjunction with this report.

This report is intended solely for the information and use of management, the Board of Directors, and others within the organization and is not intended to be, and should not be, used by anyone other than these specified parties.

Yours truly,

Deloitte & Touche LLP

APPENDIX

SECTION I — OTHER MATTERS

Other matters related to new pronouncements that we wish to bring to your attention are as follows:

GASB Statement No. 68: *Accounting and Financial Reporting for Pensions* was issued in June 2012 and establishes accounting and financial reporting requirements related to pensions for governments whose employees are provided with pensions through pension plans, as well as for nonemployer governments that have a legal obligation to contribute to those plans. This statement requires the recognition of the entire net pension liability and a more comprehensive measure of pension expense, along with additional required footnote disclosures. This standard becomes effective for the District in fiscal year 2015.

GASB Statement No. 69: *Government Combinations and Disposals of Government Operations* was issued in January 2013 and establishes accounting and financial reporting standards for government combinations and disposals of government operations. This statement distinguishes between government mergers and acquisitions and provides guidance on the appropriate accounting treatment of each. This Statement also provides guidance for transfers of operations that do not constitute entire legally separate entities and in which no significant consideration is exchanged. GASB 69 becomes effective for the District in fiscal year 2015, and should be applied on a prospective basis.

GASB Statement No. 71: *Pension Transition for Contributions Made Subsequent to the Measurement Date, an amendment of GASB Statement No. 68* was issued in November 2013 and addresses an issue relates to amounts associated with contributions, if any, made by a state or local government employer or nonemployer contributing entity to a defined benefit pension plan after the measurement date of the government's beginning net pension liability. This standard becomes effective for the District in fiscal year 2015.

SECTION II — DEFINITIONS

The definitions of a deficiency and a material weakness are as follows:

A *deficiency* exists when the design or operation of a control does not allow management or employees, in the normal course of performing their assigned functions, to prevent, or detect and correct misstatements on a timely basis.

A *material weakness* is a deficiency, or a combination of deficiencies, in internal control over financial reporting, such that there is a reasonable possibility that a material misstatement of the entity's financial statements will not be prevented, or detected and corrected on a timely basis.

SECTION III - MANAGEMENT'S RESPONSIBILITY FOR, AND THE OBJECTIVES AND LIMITATIONS OF, INTERNAL CONTROL OVER FINANCIAL REPORTING

The following comments concerning management's responsibility for internal control over financial reporting and the objectives and inherent limitations of internal control over financial reporting are adapted from auditing standards generally accepted in the United States of America.

Management's Responsibility

The District's management is responsible for the overall accuracy of the financial statements and their conformity with generally accepted accounting principles. In this regard, management is also responsible for establishing and maintaining effective internal control over financial reporting.

Objectives of Internal Control over Financial Reporting

Internal control over financial reporting is a process effected by those charged with governance, management, and other personnel and designed to provide reasonable assurance about the achievement of the entity's objectives with regard to reliability of financial reporting, effectiveness and efficiency of operations, and compliance with applicable laws and regulations. Internal control over the safeguarding of assets against unauthorized acquisition, use, or disposition may include controls related to financial reporting and operations objectives. Generally, controls that are relevant to an audit of financial statements are those that pertain to the entity's objective of reliable financial reporting (i.e., the preparation of reliable financial statements that are fairly presented in conformity with generally accepted accounting principles).

Inherent Limitations of Internal Control over Financial Reporting

Because of the inherent limitations of internal control over financial reporting, including the possibility of collusion or improper management override of controls, material misstatements due to error or fraud may not be prevented or detected and corrected on a timely basis. Also, projections of any evaluation of the effectiveness of the internal control over financial reporting to future periods are subject to the risk that the controls may become inadequate because of changes in conditions, or that the degree of compliance with the policies or procedures may deteriorate.

* * * * *

TARRANT REGIONAL WATER DISTRICT

FORT WORTH, TEXAS

Annual Financial Report
As of and for the year ended
September 30, 2014

Annual Financial Report
As of and for the Year Ended
September 30, 2014

Board of Directors

Victor W. Henderson, President

Jack R. Stevens, Vice-President

Martha V. Leonard, Secretary

James W. Lane, Secretary Pro-Tem

Mary Kelleher, Director

General Manager

James M. Oliver

Deputy General Manager

R. Alan Thomas

Director of Finance

Sandra Newby

TARRANT REGIONAL WATER DISTRICT – FORT WORTH, TEXAS

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INDEPENDENT AUDITORS' REPORT

Members of the Board of Directors
Tarrant Regional Water District
Fort Worth, Texas

Report on the Financial Statements

We have audited the accompanying financial statements of the governmental activities, business-type activities, discretely presented component unit, and the major fund of Tarrant Regional Water District (the "District"), as of and for the year ended September 30, 2014, and the related notes to the financial statements, which collectively comprise the District's basic financial statements as listed in the table of contents.

Management's Responsibility for the Financial Statements

Management is responsible for the preparation and fair presentation of these financial statements in accordance with accounting principles generally accepted in the United States of America; this includes the design, implementation, and maintenance of internal control relevant to the preparation and fair presentation of financial statements that are free from material misstatement, whether due to fraud or error.

Auditor's Responsibility

Our responsibility is to express opinions on these financial statements based on our audit. We conducted our audit in accordance with auditing standards generally accepted in the United States of America. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether the financial statements are free from material misstatement.

An audit involves performing procedures to obtain audit evidence about the amounts and disclosures in the financial statements. The procedures selected depend on the auditor's judgment, including the assessment of the risks of material misstatement of the financial statements, whether due to fraud or error. In making those risk assessments, the auditor considers internal control relevant to the entity's preparation and fair presentation of the financial statements in order to design audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on the effectiveness of the entity's internal control. Accordingly, we express no such opinion. An audit also includes evaluating the appropriateness of accounting policies used and the reasonableness of significant accounting estimates made by management, as well as evaluating the overall presentation of the financial statements.

We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our audit opinions.

Opinions

In our opinion, the financial statements referred to above present fairly, in all material respects, the respective financial position of the governmental activities, the business-type activities, the discretely presented component unit, and the major fund of Tarrant Regional Water District as of September 30, 2014, and the respective changes in financial position and, where applicable, cash flows thereof for the year then ended in accordance with accounting principles generally accepted in the United States of America.

Other Matters

Required Supplementary Information

Accounting principles generally accepted in the United States of America require that management's discussion and analysis, General Fund budgetary comparison information, and Other Post-Employment Benefits Schedule of Funding Progress and Employer Contributions be presented to supplement the basic financial statements. Such information, although not a part of the basic financial statements, is required by the Governmental Accounting Standards Board who considers it to be an essential part of financial reporting for placing the basic financial statements in an appropriate operational, economic, or historical context. We have applied certain limited procedures to the required supplementary information in accordance with auditing standards generally accepted in the United States of America, which consisted of inquiries of management about the methods of preparing the information and comparing the information for consistency with management's responses to our inquiries, the basic financial statements, and other knowledge we obtained during our audit of the basic financial statements. We do not express an opinion or provide any assurance on the information because the limited procedures do not provide us with sufficient evidence to express an opinion or provide any assurance.

Other Information

Our audit was conducted for the purpose of forming opinions on the financial statements that collectively comprise the District's basic financial statements. The accompanying Required Texas Commission on Environmental Quality Schedules and Statistical Section Schedules are presented for purposes of additional analysis and are not a required part of the basic financial statements.

The required Texas Commission on Environmental Quality schedules and Statistical Section Schedules have not been subjected to the auditing procedures applied in the audit of the basic financial statements, and accordingly, we do not express an opinion or provide any assurance on them.

Deloitte & Touche LLP

January 9, 2015

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TARRANT REGIONAL WATER DISTRICT

MANAGEMENT'S DISCUSSION AND ANALYSIS
FOR THE YEAR ENDED SEPTEMBER 30, 2014 (UNAUDITED)

This section of Tarrant Regional Water District's (the "District") annual financial report presents our discussion and analysis of the District's financial performance during the fiscal year ended September 30, 2014. Please read this analysis in conjunction with the District's audited financial statements, which follow this discussion.

FINANCIAL HIGHLIGHTS

NET POSITION

The assets and deferred outflows of the District exceeded its liabilities and deferred inflows at the close of the most recent fiscal year by $831.0 million (*net position*). Of this amount, $152.0 million (unrestricted net position) may be used to meet the District's ongoing obligations to citizens and creditors.

At the end of the current fiscal year: Business-Type Activities total net position increased by $33.6 million mainly due to the increase in net investment in capital assets, for design and construction related to the 2009, 2010, 2012, and 2014 bond issues. Governmental activities total net position increased by $49.8 million mainly due to the continuation of several large capital projects such as Twin Points and the Trinity River Vision Project.

OVERVIEW OF LARGE PROJECTS

The District engaged in multiple large, water supply related, construction projects funded through bond issues, as well as the Trinity River Vision Project which is funded through oil and gas and Tax Increment Reinvestment Zone #9 revenues and other smaller construction related projects. These projects are discussed on the following pages.

ENTERPRISE FUND-WATER SUPPLY PROJECTS

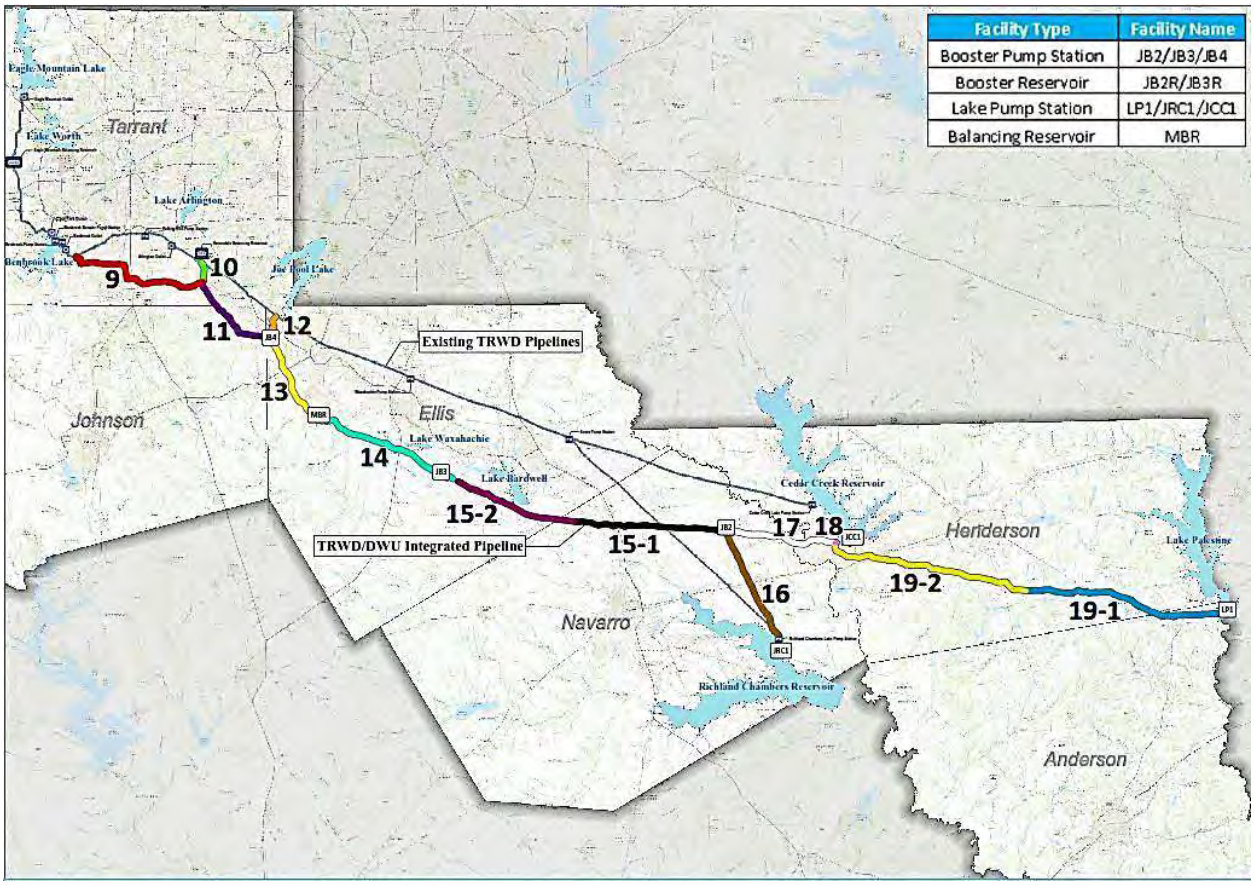
Third East Texas Pipeline/Integrated Pipeline

The District and the City of Dallas Water Utilities (DWU) have partnered to finance, plan, design, construct, and operate the Integrated Pipeline (IPL) Project. The IPL Project is an integrated water delivery transmission system connecting Lake Palestine to Lake Benbrook with connections to Cedar Creek and Richland-Chambers Reservoirs that integrates the District's existing pipeline system and creates flexibility in delivery as well as quick response to fluctuating customer water demands. The IPL Project consists of 150 miles of pipeline, three new lake pump stations, and three new booster pump stations, delivering a required capacity of 350 million gallons (MGD) of raw water per day to North Central Texas. The District and DWU currently serve over 4.1 million residents and the IPL Project will allow these agencies to continue supporting regional community and economic growth. On-going studies, additional design, and construction are being paid for with the TRWD 2009, 2010, 2012 and 2014, DWU 2012 and 2014 bond issues, as well as future bond issues. The estimated total cost to the District for this project is approximately $1.4 billion and Dallas Water Utilities is approximately $938 million. As of September 30, 2014, $350 million in cost has been incurred for the IPL Project.

Progress for this project is as follows:

- Final design for the core portion of the project is at 90% complete on the pipeline, 95% complete on the pump stations, and 100% complete on the reservoirs
- The project has acquired 243 of the 522 required parcels as of September 2014
- The Richland Chambers line lowering was completed in May 2014
- Construction on the first section of the pipeline, Section 15, was bid and construction began in Spring of 2014. Of this $92.9 million contract, $48.1 million of costs were incurred in FY14.
- Various valves (butterfly, gate, and multi-orifice valves) to control water and enable construction have been bid out during 2014, and are expected to begin installation in January 2015.
- The construction of the joint booster pump station JB3 was bid and a contract signed for $11.4 million. Construction began in Summer of 2014 and $662 thousand of costs were incurred in FY14.
- Pipeline section 12, 13, and the Midlothian Balancing Reservoir were bid and a contract signed for $149.6 million in FY14.

On the following page is a general overview depicting the District's existing East Texas Pipeline and the new IPL pipeline to the south of the existing line:



Picture 1- Overview of Integrated Pipeline

Richland-Chambers Wetlands

The George W. Shannon Wetlands at Richland-Chambers Reservoir is located southeast of the reservoir and in northern Freestone and southern Navarro Counties, and are used to polish the Trinity River water to a quality such that no adverse impacts will be seen as it is introduced in the reservoir. The last phase of construction brought the project to its ultimate size of just over 2,000 acres.

The final expansion started construction during the winter of 2011. It included additional acres of wetlands, various canals, and other structures such as sediment basins and flexible base pavement for driving equipment out onto the property. The Wetlands became operational in fall of 2014.

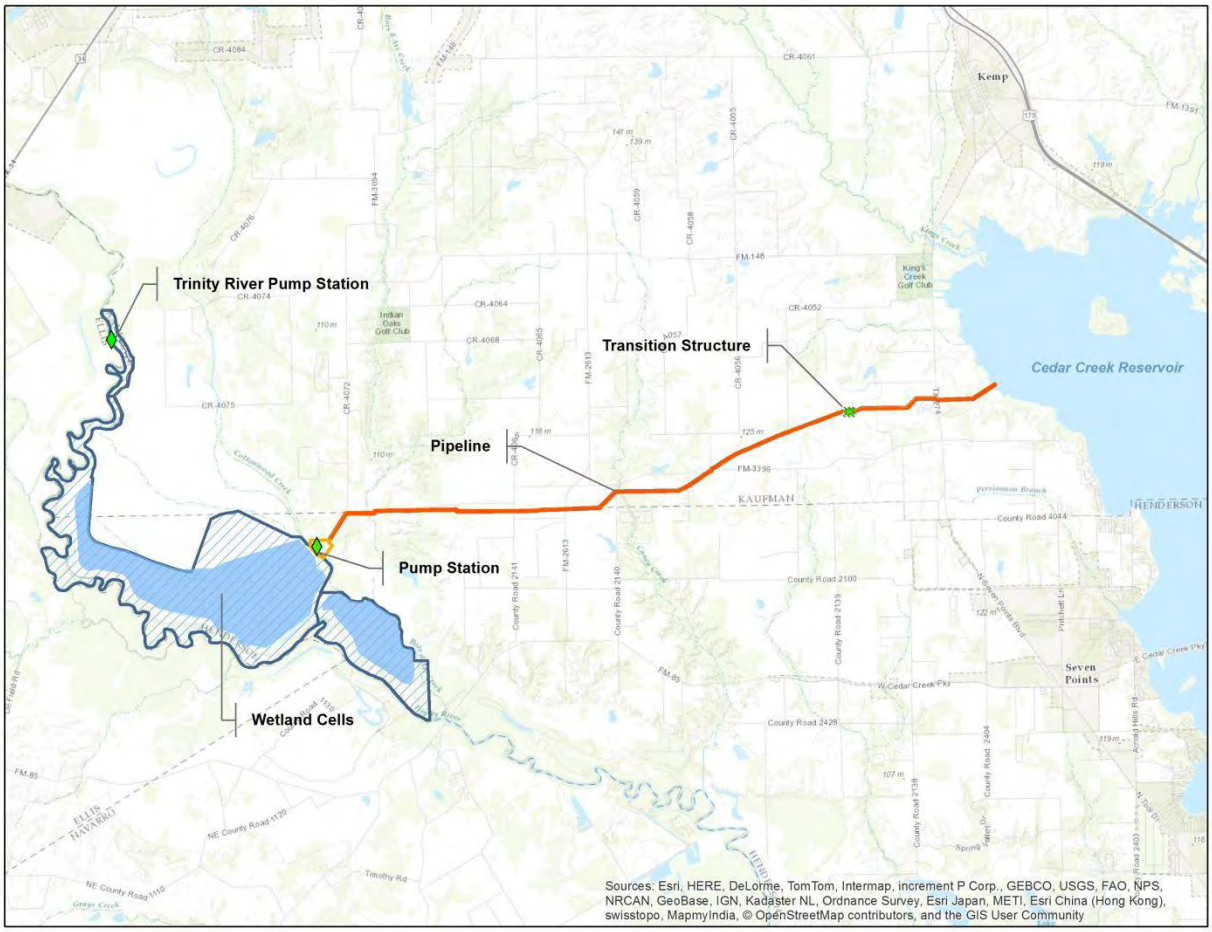
A total of $72.5 million was spent on the full footprint of the Richland-Chambers Wetlands Project. These funds were paid for with multiple bond issues (1999, 2002, 2006, 2008A, and 2010).

A picture showing the completed George W. Shannon Wetlands is shown below:

Picture 2 – Completed George W. Shannon Wetlands

Cedar Creek Wetlands

The proposed wetlands at Cedar Creek Reservoir have completed preliminary design. The area of interest of the project location is in northern Kaufman County to the west of the reservoir. The facility is planned to be constructed in one effort which will include the construction of a pump station at the Trinity River, 2,000 acres of wetland cells and associated structures, a final pump station, and its associated pipeline to transport 80 million gallons of treated water per day from the wetlands into the reservoir. Preliminary design efforts were funded with the 2008B bond issue and to date $4.3 million has been spent on design. Land acquisition for the Cedar Creek Wetlands was funded with the 2010 bond issue. In January 2014 the District began securing 4,192 acres for the wetlands project site in Henderson and Kaufman Counties. To date, $15.2 million has been spent on land acquisition. The acquisition of the facilities sites as well as the pipeline right of way should be completed in 2015. A drawing of the proposed Cedar Creek Wetlands is shown below:



Picture 3 - Cedar Creek Wetlands

Line J Section 1C Kennedale Balancing Reservoir Expansion

This project will install an additional pipeline from the Kennedale Balancing Reservoir (KBR) to the Arlington outlet and a third cell at the Kennedale Balancing Reservoir. These components will improve operations, increase reliability and add redundancy to the system. The proposed expansion will provide an additional 150 million gallons of storage by adding a third cell to KBR. The construction of this pipeline was completed in September 2014 at a cost of $24.1 million. The construction of the third cell is expected to start in 2020. Below is a photograph of workers lowering an 84" tee into place on Line J:

Picture 4 – Lowering tee into place on Kennedale Line J Section 1C

GENERAL FUND PROJECTS

Trinity River Vision Project

The United States Army Corps of Engineers (USACE) and the District have been partnering to address water resources needs associated with the Trinity River for more than fifty years. After severe flooding in the late 1940s Congress authorized the Fort Worth Floodway Program which allowed the USACE to construct a flood protection system on the Trinity River in Fort Worth. This created the Fort Worth Floodway as we know it today. The District is the local sponsor of the Fort Worth Floodway and responsible for operation and maintenance of thirty miles of river and trail system. In the mid-1980s, the USACE, in cooperation with the District and other regional sponsors, began a series of Trinity River planning and flood plan management initiatives basin-wide, which ultimately led to the Trinity River Vision Project (TRV).

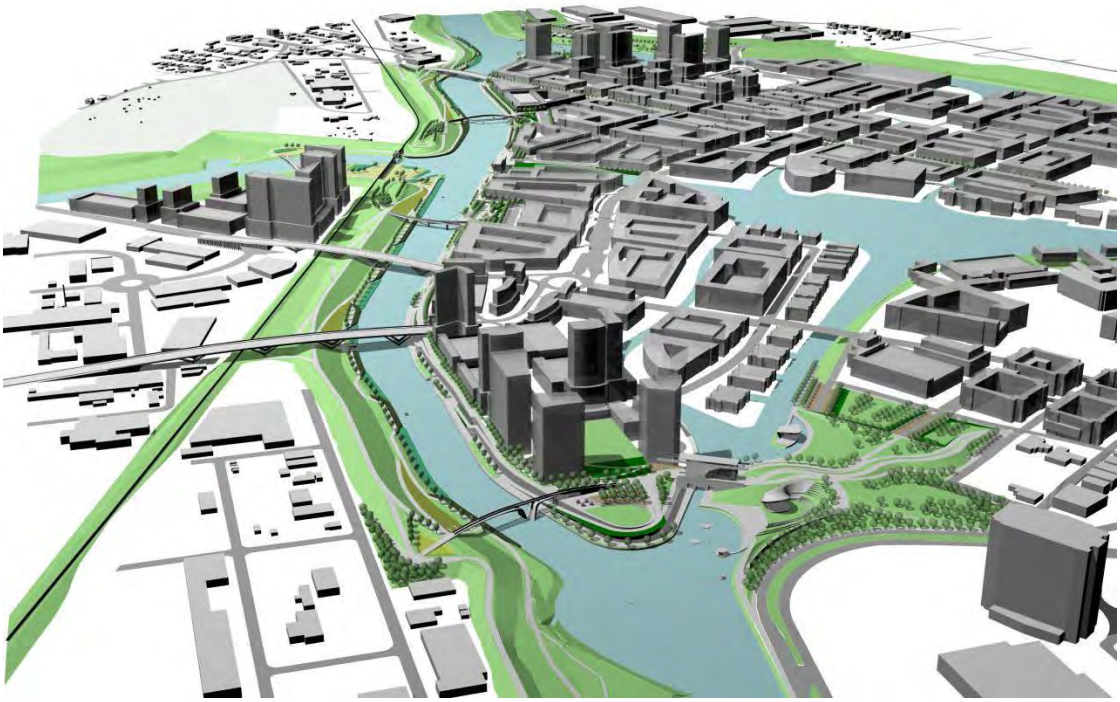
This project is a multi-agency collaboration between the District, TRV, Texas Department of Transportation (TxDOT), USACE, the City of Fort Worth, and Tarrant County, bringing flood protection and related infrastructure to an 800 acre area north of downtown Fort Worth between the Tarrant County Courthouse and Northside Drive. The key component is the construction of a bypass channel, approximately 1.5 miles long, which will divert flood flows around the segment of the Trinity River adjacent to downtown. Construction of this new bypass channel and related dam and isolation gates will allow the existing river to function as a "quiescent watercourse"-a calm, constant-level, lake-like body that can be enjoyed all year round.

As of September 30, 2014 the TRV project has accomplished the following:

- 268 businesses and tenants have been successfully relocated.
- Property continues to be acquired based on project schedule needs.
- Demolition work was completed in the Henderson Street, White Settlement, and Main Street corridors in preparation for bridge construction.
- Henderson Street, White Settlement, and Main Street Bridge design is 100% complete.
- TxDOT let a contract for all three bridges in May and mobilized in September.
- The Henderson Street detour was completed and will be used during bridge construction.
- Final design on bypass channel continues.
- Water and sanitary sewer lines were relocated by the City of Fort Worth and franchise utility relocation was completed in the areas required for bridge construction.
- Design work for valley storage at Gateway Park Sites A & C was completed, and Rockwood Park and Riverside Park design continues.
- Ham Branch Valley Storage design was completed in preparation for construction in the future.
- Design work on pedestrian bridges is at 60%.

As of year-end, the District and the Trinity River Vision Authority (TRVA) have spent a total of $64.4 million on this project. The City of Fort Worth Tax Increment Reinvestment Zone Number Nine in accordance with the project cost funding agreement as described in Note 1, which accompanies the financial statements, has spent $108.5 million on the project including $2.6 million of expenses paid directly by the Tax Increment Reinvestment Zone. The remaining outstanding loan to TRWD is $92.0 million. Pictures depicting detours being built and conceptual design sketches are below and on the following page:

Picture 5 – New blacktop laid to detour Henderson St. traffic during construction



Picture 6 – Conceptual overview of the bypass channel

Annex West Administration Building

The Annex West Administration Building consists of a single story office building containing offices, work room, training room, conference rooms and associated ancillary spaces to accommodate expanding staff needed for the many large projects the District is working on. The building also includes a vault designed to withstand a category F5 tornado. In addition, this project includes the expansion of the existing parking lot and a separate two level parking structure. The building is 16,046 square feet and the parking structure is 52,800 square feet. The Annex West Administration Building and the parking garage were completed in spring of 2014. Photos of the new building and garage are shown on the following page:

Picture 7 - Annex West Administration Building

Picture 8 - Administration Parking Garage

Twin Points Park

The Twin Points Park project has been ongoing since 2010. To date, the District has spent $5.7 million for cleanup, a boat ramp, docks, paved parking areas, fence and gated park access, and additional restrooms. Now in Phase 2B of the project, a swim area and beach area are in progress. Construction on these portions of the project began within the park during Fiscal Year 2014. Future plans include concessions and RV parking areas. See the progress that has been made on the Phase 2B swim beach retaining walls in the picture below.

Picture 9 – Twin Points Park Swim Beach Retaining Walls

Airfield Falls Conservation Park

A new conservation garden and trailhead will honor the history of the Naval Air Station Joint Reserve Base (NASJRB) with an educational art piece featuring military aircraft components. These components consist of wings and a tail section of a C-9 military aircraft that have been donated by the NASJRB. The new amenities will be a unique way to represent the rich history of the region from its transformation from a Bomber Plant to Lockheed Martin to Carswell to now the NASJRB. Other amenities such as parking, restroom, water fountain and picnic tables will be on site as well.

In addition to new recreation opportunities, the project also focuses on another of the District's missions with the addition of a conservation garden deemed the "Walk of a Thousand Plants". This garden will feature native plants so visitors of Airfield Falls will be able to see how and what to plant during different seasons to help conserve water. To date, the District has spent $1.6 million on this project. Below is a photograph of the garden under construction:

Picture 10 – Airfield Falls Terrace Area

Marine Creek Trailhead and Park

The District and Tarrant County Precinct 4 partnered to construct two miles of 12 foot wide asphalt trail that will provide access for Tarrant County College and the new neighborhoods to enjoy further improvements around Marine Creek Lake. This will also help the District's effort to link this trail to the rest of the Trinity Trail system. So far, the District has spent $2.2 million on trailhead improvements. In Fiscal Year 2015 the District plans to build a parking area, boat ramp, pavilions, and restrooms along the trail. Below is a portion of the trails around Marine Creek Lake.

Picture 11 – A portion of the trails around Marine Creek Lake

OVERVIEW OF THE FINANCIAL STATEMENTS

This discussion and analysis is intended to serve as an introduction to the District's basic financial statements. The District's basic financial statements contain three components: 1) Government-wide financial statements, 2) fund financial statements, and 3) notes to the financial statements. The report also contains other required supplementary information in addition to the basic financial statements.

Government-wide Financial Statements

The government-wide financial statements are designed to provide readers with a broad overview of the District's finances, presented in a manner similar to that of a private-sector business.

Statement of Net Position

The Statement of Net Position presents information on all of the District's assets and liabilities. The difference between those assets and liabilities are reported as net position. Over time, increases and decreases in net position could provide a useful indicator of whether the financial position of the District is improving or deteriorating.

Statement of Activities

The Statement of Activities presents information showing how the District's net position has changed during the most recent fiscal year. All changes in net position are reported as soon as the underlying event giving rise to the change occurs, regardless of the timing of related cash flows.

Both the Statement of Net Position and the Statement of Activities distinguish between the two functions of the District. Property taxes, oil and gas royalties, and inter-governmental revenues support the governmental activities. These activities include flood control, floodway maintenance, and improvements, recreation, and general government administration. The business-type activities of the District are intended to recover all or a significant portion of their costs through user fees and charges. The District's business-type activity is supplying raw water to municipalities. The government-wide financial statements can be found beginning on Page 26 and 27 of this report.

Fund Financial Statements

A fund is a grouping of related accounts that is used to maintain control over resources that have been segregated for specific activities or objectives. The funds of the District can be divided into two categories: governmental and proprietary.

Governmental Funds

Governmental funds are used to account for the same functions shown in the governmental activities on the Statement of Activities mentioned above. However, unlike the government-wide financial statements, governmental fund financial statements focus on near-term inflows and outflows and the expending of available resources, as well as on balances of resources available at the end of the fiscal year.

Because the focus of governmental funds is narrower than that of the government-wide financial statements, it is useful to compare the information presented for governmental funds with similar information presented for governmental activities in the government-wide financial statements. Both the governmental fund balance sheet and the governmental fund statement of revenues, expenditures, and changes in fund balances provide reconciliations to facilitate this comparison between governmental funds and governmental activities. The District maintains only one governmental fund: the General Fund.

Proprietary Funds

Proprietary funds are used to report the same functions presented as business-type activities in the government-wide financial statements. The District's proprietary funds account for the raw water system, its repairs, and its improvements.

Component Unit

Component units are organizations that are legally separate, tax exempt entities that have the following characteristics: 1) the economic resources received or held are almost entirely for the direct benefit of the primary government, 2) the primary government has the ability to access a majority of the economic resources held by the separate organization and 3) the assets held by the separate entity are significant to the primary government. The District has one discretely-presented component unit: the Trinity River Vision Authority.

Notes to the Financial Statements

The notes provide additional information that is essential to a full understanding of the data provided in the government-wide and fund financial statements. The notes to the financial statements can be found beginning on page 39 of this report.

FINANCIAL ANALYSIS: GOVERNMENT-WIDE STATEMENTS

As noted earlier, net position may serve over time as a useful indicator of a government's financial position. In the case of the District, assets and deferred outflows exceeded liabilities and deferred inflows by $831.0 million at the close of the 2014 fiscal year.

CONDENSED SCHEDULE OF NET POSITION

	Governmental Activites		Business-Type Activites		Total	
	2013	2014	2013	2014	2013	2014
Current and other assets	$ 204,514,896	$ 217,260,350	$ 317,363,230	$ 752,025,675	$ 521,878,126	$ 969,286,025
Capital assets	221,301,902	279,586,633	908,230,255	1,063,297,783	1,129,532,157	1,342,884,416
Total Assets	$ 425,816,798	$ 496,846,983	$ 1,225,593,485	$ 1,815,323,458	$ 1,651,410,283	$ 2,312,170,441
Deferred Outflows of Resources	$ -	$ -	$ 50,088	$ -	$ 50,088	$ -
Current liabilites	$ 5,107,216	$ 9,849,698	$ 59,034,952	$ 89,445,012	$ 64,142,168	$ 99,294,710
Long-term liabilities	11,380,940	27,899,372	825,495,524	1,351,542,092	836,876,464	1,379,441,464
Total Liabilities	$ 16,488,156	$ 37,749,070	$ 884,530,476	$ 1,440,987,104	$ 901,018,632	$ 1,478,736,174
Deferred Inflows of Resources	$ -	$ -	$ 2,800,573	$ 2,469,138	$ 2,800,573	$ 2,469,138
Net position:						
Net investment in capital assets	$ 221,301,902	$ 279,586,633	$ 275,649,460	$ 308,579,683	$ 496,951,362	$ 588,166,316
Restricted for debt service			63,522,458	90,811,279	63,522,458	90,811,279
Unrestricted	188,026,740	179,511,280	(859,394)	(27,523,746)	187,167,346	151,987,534
Total Net Position	$ 409,328,642	$ 459,097,913	$ 338,312,524	$ 371,867,216	$ 747,641,166	$ 830,965,129

Government-wide

- **Current and Other Assets (includes all assets other than Capital Assets)**
  Current and Other assets increased from $521.9 million to $969.3 million mainly due to bond proceeds from the 2014 bond issue of $520.9 million.

- **Capital Assets**
  Capital assets increased from $1.1 billion to $1.3 billion due to the ongoing acquisition of property for the Trinity River Vision project and design and construction related to the 2009, 2010, 2012 and 2014 bond issues which included projects such as the Wetlands at Richland-Chambers and Cedar Creek Reservoirs, the IPL project, and other various large projects.

- **Net Investment in Capital Assets**
  The District has $588.2 million (71%) of its net position in Capital Assets (e.g. dams, spillways and water transmission facilities as well as land, buildings, machinery, and equipment); less any related debt used to acquire those assets that is still outstanding. The District uses the majority of these capital assets to provide services to its water customers; consequently, those assets are not available for future spending.

Although the District's investment in capital assets is reported net of related debt, it should be noted that the resources needed to repay this debt must be provided from other sources, since the capital assets themselves cannot be used to liquidate these liabilities.

- **Restricted for Debt Service**
  An additional $90.8 million (11%) of the District's net position represents resources that are subject to restrictions for debt service.

- **Unrestricted Net Position**
  The remaining balance of $152.0 million (18%) is considered unrestricted net position and may be used to meet the District's ongoing liabilities.

Governmental Activities

- **Current and other assets**
  Increase of $12.7 million was due mainly to the $41.0 million increase in the long-term receivable related to the Tax Increment Reinvestment Zone Project Cost Funding Agreement, netted with a decrease of $29.3 million in cash and investments carried in the General Fund because of ongoing spending on General Fund capital asset projects.

- **Capital Assets**
  Increase of $58.3 million was due to the TRV Project and ongoing park and trail construction.

Business-Type Activities

- **Current and Other Assets**
  Current and Other assets increased from $317 million to $752 million largely due to bond proceeds from the issuance of $520.9 million of new debt netted with expenditures for the on-going IPL project.

- **Capital Assets**
  Capital assets increased from $908 million to $1.1 billion due to on-going bond projects with the largest being the Integrated Pipeline.

- **Long-Term Liabilities**
  Long-Term Liabilities increased from $825 million to $1.4 billion due mostly to the issuance of $521 million of new debt.

CONDENSED SCHEDULE OF ACTIVITIES

	Governmental Activities		Business-Type Activities		Total	
	2013	2014	2013	2014	2013	2014
Revenues:						
Program Revenues:						
Charges for services	$ 33,255,675	$ 26,048,278	$ 120,270,336	$ 136,041,137	$ 153,526,011	$ 162,089,415
Capital Contributions	31,910,810	49,101,393	-	-	31,910,810	49,101,393
Total Program Revenues	65,166,485	75,149,671	120,270,336	136,041,137	185,436,821	211,190,808
General Revenues:						
Property tax revenues	9,013,033	9,231,193	-	-	9,013,033	9,231,193
Unrestricted investment income	300,771	367,655	262,520	1,598,019	563,291	1,965,674
Other revenues	328,577	94,854	988,288	817,080	1,316,865	911,934
Total Revenues	74,808,866	84,843,373	121,521,144	138,456,236	196,330,010	223,299,609
Expenses:						
General government	11,521,503	13,462,903	-	-	11,521,503	13,462,903
Flood control	6,313,528	3,241,255	-	-	6,313,528	3,241,255
TRV Contribution	1,041,910	18,369,944	-	-	1,041,910	18,369,944
Water supply	-	-	87,165,497	104,901,544	87,165,497	104,901,544
Total Expenses	18,876,941	35,074,102	87,165,497	104,901,544	106,042,438	139,975,646
Changes in Net Position	55,931,925	49,769,271	34,355,647	33,554,692	90,287,572	83,323,963
Net Position - Beginning	353,396,717	409,328,642	312,220,780	338,312,524	665,617,497	747,641,166
Change in Accounting Principle due to implementation of GASB 65	-	-	(8,263,903)	-	(8,263,903)	-
Net Position - Beginning	353,396,717	409,328,642	303,956,877	338,312,524	657,353,594	747,641,166
Net Position - Ending	$ 409,328,642	$ 459,097,913	$ 338,312,524	$ 371,867,216	$ 747,641,166	$ 830,965,129

Governmental Activities

- **Charges for Services**
  Decrease of $7.2 million is due primarily to decreased oil and gas revenues.

- **Capital Contribution**
  Increase of $17.2 million due to an increase in the TIF contribution, as well as a land swap where the land contributed to TRWD was worth $4.6 million more than the land being traded away.

- **TRV Contribution Expense**
  Increase of $17.3 million is due to the contribution of the White Settlement Bridge asset, as well as a cash contribution for use on the White Settlement Bridge project, to Texas Department of Transportation.

Business Type Activities

- **Program Revenues – Charges for Services**
  Increased $18.6 million due to increased pumping power and debt service charged to customers.

- **Expenses – Water Supply**
  Expenses for the water supply increased $17.7 million mainly due to the District using more electricity for pumping power because of decreasing lake levels and drought conditions. Also, bond expenses increased $3 million due to increased bond activity in fiscal year 2014.

FINANCIAL ANALYSIS: FUND STATEMENTS

General Fund

As of the end of the 2014 fiscal year, the District's General Fund reported an ending fund balance of $115.7 million, a decrease of $33.3 million in comparison to the prior year. This total includes Non-spendable fund balance in the amount of $3.7 million, and $111.9 million in an Unassigned Fund Balance, which is available for spending at the District's discretion.

The General Fund includes floodway support and maintenance, flood control efforts, recreation, and general administrative costs. Tax revenues, oil and gas royalties, and a reimbursement from the Proprietary Funds for allocated costs provide the major sources of revenue.

Enterprise Fund

The District's enterprise fund provides the same type of information found in the government-wide financial statements, but without comparative data for the prior year.

End of year Net Position is $371.9 million.

FINANCIAL ANALYSIS: CAPITAL ASSETS

The District's capital assets for its governmental and business-type activities as of September 30, 2014 were $1.3 billion. Capital assets include: dams, spillways and water transmission facilities as well as land, roads, buildings, machinery, equipment, construction costs, and surplus water rights.

Major asset events during the current year included the following:

- **Land – Governmental Activities**
  - Trinity River Vision project land, relocation, demolition, and environmental costs including pollution remediation increased the land balance by $37.8 million.
- **Construction in Progress – Governmental Activities**
  - Trinity River Vision construction in progress increased by $7.5 million.
  - Twin Points Project increased by $1.3 million.
  - Airfield Falls Trailhead increased by $1.3 million.
  - The Annex West Administration building was completed and $6.6 million of prior year costs were transferred to depreciable buildings.
- **Buildings – Governmental Activities**
  - The District completed construction on the new $7.6 million Annex West Administration Building and parking garage, with $1.0 million of that cost in the current fiscal year.
- **Land – Business-type Activities**
  - Integrated Pipeline land purchases of $18.0 million.
  - Purchased $15.0 million related to the Cedar Creek Wetlands.
- **Construction in Progress – Business-type Activities**
  - Richland-Chambers Wetland's current phase was completed and $43.3 million of prior year costs were transferred to depreciable wetlands.
  - Integrated Pipeline increased $97.4 million.
  - Arlington Outlet Hydroelectric Generation increased $1.2 million.
  - Kennedale Balancing Reservoir Line J Section 1C increased $6.0 million.
  - Cedar Creek Dam Stability Analysis increased $3.2 million.
  - Pump Room Cooling Project increased $1.6 million.
  - Capitalized Interest on construction in progress increased $3.7 million net of transfers to other project costs.
- **Pipeline**
  - Updating Variable Frequency Drive at Richland Chambers was completed for a total cost of $3.1 million of which $2.3 million was cost in the current fiscal year.
- **Wetlands**
  - The District completed construction on the current $45.3 million phase of the Richland-Chambers Wetlands, with $2.0 million of that cost in the current fiscal year.
- **Other Project Costs**
  - Capitalized Interest increased $17.5 million.

CAPITAL ASSETS

	Governmental Activities		Business-Type Activities		Total	
	2013	2014	2013	2014	2013	2014
Nondepreciable:						
Land	$ 141,387,171	$ 187,854,778	$ 100,739,236	$ 133,783,193	$ 242,126,407	$ 321,637,971
Construction in progress	55,144,489	58,960,125	294,255,165	363,799,258	349,399,654	422,759,383
Total nondepreciable assets	196,531,660	246,814,903	394,994,401	497,582,451	591,526,061	744,397,354
Depreciable :						
Dams and spillways	3,378,736	3,378,736	210,382,594	212,929,639	213,761,330	216,308,375
Pipeline	-	-	507,235,559	510,290,880	507,235,559	510,290,880
Wetlands	-	-	8,823,497	54,091,602	8,823,497	54,091,602
Communications	-	-	1,087,448	1,087,448	1,087,448	1,087,448
Buildings	25,361,800	34,533,160	6,769,080	6,816,587	32,130,880	41,349,747
Machinery and equipment	10,157,896	11,155,730	12,714,871	12,922,394	22,872,767	24,078,124
Flood control and other project costs	8,095,940	8,095,940	47,648,525	65,096,010	55,744,465	73,191,950
Capital Lease-Machinery & Equip	1,447,140	1,447,140	-	-	1,447,140	1,447,140
	48,441,512	58,610,706	794,661,574	863,234,560	843,103,086	921,845,266
Less:						
Accumulated depreciation	(23,147,691)	(25,025,969)	(281,987,943)	(298,011,898)	(305,135,634)	(323,037,867)
Capital Lease-Accum. Depr.	(523,579)	(813,007)	-	-	(523,579)	(813,007)
Total depreciable assets	24,770,242	32,771,730	512,673,631	565,222,662	537,443,873	597,994,392
Water rights, net of Accum Depr.	-	-	562,223	492,670	562,223	492,670
Total	$ 221,301,902	$ 279,586,633	$ 908,230,255	$ 1,063,297,783	$ 1,129,532,157	$ 1,342,884,416

BUDGETARY HIGHLIGHTS

GENERAL FUND

The 2014 budgeted revenues for the General Fund were $30.9 million and the year ended with actual revenues of $39.2 million.

The 2014 budgeted expenditures for the General Fund were $80.7 million and the year ended with actual expenditures of $72.5 million.

The Fiscal Year 2015 General Fund budgeted expenditures total $69.6 million, which is a decrease of $11.1 million over the fiscal year 2014 approved budget of $80.7 million. This decrease is due mainly to a $10.7 million decrease in ongoing construction within the General Fund. The property tax rate will remain at $.02/$100 valuation.

ENTERPRISE FUND

The fiscal year 2015 Enterprise Fund Budget, prepared in accordance with the Tarrant Regional Water Supply Facilities Amendatory Contract, totals $136.1 million. This reflects an increase of $9.7 million from the fiscal year 2014 approved budget of $126.4 million. The increase is mainly due to debt repayment which represents $7.4 million and facilities increase of $2.7 million. The total budget includes administrative expenses, operating and maintenance expenses, capital expenditures, and Debt Service that provides for principal and interest payments to retire outstanding bonds.

REQUESTS FOR INFORMATION

This financial report is designed to provide a general overview of Tarrant Regional Water District's finances. Questions concerning any of the information provided in this report or requests for additional financial information should be addressed as follows:

Sandra Newby
Director of Finance
800 East Northside Drive
Fort Worth, Texas 76102

TARRANT REGIONAL WATER DISTRICT

STATEMENT OF NET POSITION
SEPTEMBER 30, 2014

	Primary Government			
	Governmental Activities	Business-Type Activities	Total	Component Unit
ASSETS:				
Cash and cash equivalents	$ 53,637,150	$ 26,265,019	$ 79,902,169	$ 2,936,220
Investments	55,076,546	6,997,879	62,074,425	
Receivables:				
Accounts, oil and gas royalties, and other	4,131,442	1,612,535	5,743,977	58,960
Taxes-net of allowance	36,692		36,692	
Accrued interest	104,099	27,775	131,874	
Long-term receivable	91,999,716		91,999,716	
Internal balances	9,412,389	(9,412,389)	-	
Prepaid items	2,808,611	2,176,256	4,984,867	20,410
Inventory of supplies-at cost	53,705		53,705	
Cash and cash equivalents for bond projects		239,322,955	239,322,955	
Investments held for bond projects		388,917,277	388,917,277	
Accrued interest receivable for bond projects		395,809	395,809	
Cash and cash equivalents restricted		1,100,000	1,100,000	
Cash and cash equivalents for debt service		566,915	566,915	
Investments restricted for debt service		93,736,654	93,736,654	
Accrued interest receivable restricted for debt service		318,990	318,990	
Land	187,854,778	133,783,193	321,637,971	
Construction in progress	58,960,125	363,799,258	422,759,383	
Depreciable capital assets, net of accumulated depreciation	32,771,730	565,222,662	597,994,392	
Water rights, net of amortization		492,670	492,670	
Total Assets	496,846,983	1,815,323,458	2,312,170,441	3,015,590
LIABILITIES:				
Accounts payable	7,575,494	41,306,018	48,881,512	1,003,553
Accrued vacation - due within one year	201,354	580,424	781,778	
Accrued litigation judgements	195,000		195,000	
Other liabilities	1,877,850	5,492,290	7,370,140	1,987,698
Payable from restricted assets - Accrued bond interest payable		4,911,280	4,911,280	
Revenue bonds payable, net of discount				
Due within one year		37,155,000	37,155,000	
Due in more than one year		1,343,730,004	1,343,730,004	
Long-term Payables				
Pollution Remediation Obligations	24,109,409		24,109,409	
Post employment benefits payable	3,319,110	6,454,804	9,773,914	
Accrued Vacation - due in more than one year	470,853	1,357,284	1,828,137	
Total Liabilities	37,749,070	1,440,987,104	1,478,736,174	2,991,251
DEFERRED INFLOWS OF RESOURCES:				
Deferred bond refunding-gain		2,469,138	2,469,138	
NET POSITION:				
Net investment in capital assets	279,586,633	308,579,683	588,166,316	-
Restricted for debt service		90,811,279	90,811,279	-
Unrestricted	179,511,280	(27,523,746)	151,987,534	24,339
Total Net Position	$ 459,097,913	$ 371,867,216	$ 830,965,129	$ 24,339

The accompanying notes are an integral part of these financial statements.

TARRANT REGIONAL WATER DISTRICT

STATEMENT OF ACTIVITIES
FOR THE YEAR ENDED SEPTEMBER 30, 2014

Functions/Programs	Expenses	Program Revenues: Charges for services	Program Revenues: Capital Grants and Contributions	Net (Expense) Revenue and Changes in Net Position: Primary Government: Governmental Activities	Primary Government: Business Type Activities	Primary Government: Total	Component Unit
PRIMARY GOVERNMENT							
Governmental activities:							
General government	$ 13,462,903	$ 26,048,278	$ 49,101,393	$ 61,686,768		$ 61,686,768	
Flood control	3,241,255			(3,241,255)		(3,241,255)	
Trinity River Vision Project	18,369,944			(18,369,944)		(18,369,944)	
Total governmental activities	35,074,102	26,048,278	49,101,393	40,075,569		40,075,569	
Business type activities-water supply	104,901,544	136,041,137			$ 31,139,593	31,139,593	
	$ 139,975,646	$ 162,089,415	$ 49,101,393		31,139,593	71,215,162	
COMPONENT UNIT							
Trinity River Vision Authority							
Project development	37,801,538	36,140,562					$ (1,660,976)
Recreation programs	744,620	487,281	257,339				-
Total component unit	$ 38,546,158	$ 36,627,843	$ 257,339				(1,660,976)
GENERAL REVENUES (EXPENSES):							
Property taxes				9,231,193		9,231,193	
Investment income				367,655	1,598,019	1,965,674	643
Miscellaneous				48,081	773,572	821,653	1,800
Gain/loss on disposal of assets				46,773	43,508	90,281	
Total general revenues and transfers				9,693,702	2,415,099	12,108,801	2,443
CHANGES IN NET POSITION				49,769,271	33,554,692	83,323,963	(1,658,533)
NET POSITION----Beginning of year				409,328,642	338,312,524	747,641,166	1,682,872
NET POSITION-----End of year				$ 459,097,913	$ 371,867,216	$ 830,965,129	$ 24,339

The accompanying notes are an integral part of these financial statements.

TARRANT REGIONAL WATER DISTRICT

BALANCE SHEET—GENERAL FUND
SEPTEMBER 30, 2014

ASSETS:	
Cash and cash equivalents	$ 53,637,150
Investments	55,076,546
Receivables:	
Oil and gas royalties and other	4,131,442
Taxes—net	36,692
Accrued interest	104,099
Due from Enterprise Fund	8,538,375
Notes and interest due from enterprise fund	874,014
Prepaid items	2,808,611
Inventory of supplies —at cost	53,705
Long-term receivable	91,999,716
Total assets	$ 217,260,350
LIABILITIES:	
Accounts payable	$ 7,575,494
Accrued litigation and judgements	195,000
Other liabilities	1,389,467
Total liabilities	9,159,961
DEFERRED INFLOWS:	
Unavailable revenue	92,427,433
Total deferred inflows	92,427,433
FUND BALANCES:	
Nonspendable:	
Long-term interfund notes and interest	874,014
Prepaid items	2,808,611
Inventory of supplies - At cost	53,705
Unassigned	111,936,626
Total fund balances	115,672,956
TOTAL	$ 217,260,350

The accompanying notes are an integral part of these financial statements.

TARRANT REGIONAL WATER DISTRICT

RECONCILIATION OF BALANCE SHEET-GENERAL FUND TO GOVERNMENT-WIDE STATEMENT OF NET POSITION SEPTEMBER 30, 2014

TOTAL FUND BALANCES—General Fund	$	115,672,956
Amounts reported for governmental activities in the statement of net assets are different because:		
Certain revenues do not provide current financial resources and therefore are unavailable at the fund level		
TIF Loan Long-Term Receivable		91,999,716
Property Taxes		11,996
Oil and Gas Revenues known but not paid wihtin 60 days of year end		415,721
Certain liabilities are not payable from current resources and are therefore not accrued at the fund level		(28,100,726)
Certain leases are not due and payable in the current period and therefore are not reported as liabilities to governmental funds		(488,383)
Capital assets used in governmental activities are not financial resources and therefore are not reported as assets in governmental funds		279,586,633
TOTAL NET POSITION—Governmental activities	$	459,097,913

The accompanying notes are an integral part of these financial statements.

TARRANT REGIONAL WATER DISTRICT

STATEMENT OF REVENUES, EXPENDITURES, AND CHANGES IN FUND BALANCE—GENERAL FUND
FOR THE YEAR ENDED SEPTEMBER 30, 2014

REVENUES:	
Property taxes	$ 9,263,039
Lease rentals	1,314,725
Oil and gas royalties	24,518,478
Sale of Rock and Gravel	12,500
Investment income	367,655
Contributions	3,386,255
Other	311,573
Total revenues	39,174,225
EXPENDITURES:	
Current:	
General and administrative	9,043,006
Personnel services	4,821,935
Pension plan contribution	512,818
Contribution to Component Unit	18,434,944
Capital expenditures	39,365,013
Capital lease payment	277,377
Total expenditures	72,455,093
DEFICIENCY OF REVENUES UNDER EXPENDITURES	(33,280,868)
CHANGE IN FUND BALANCE	(33,280,868)
FUND BALANCE—Beginning of year	148,953,824
FUND BALANCE—End of year	$ 115,672,956

The accompanying notes are an integral part of these financial statements.

TARRANT REGIONAL WATER DISTRICT

RECONCILIATION OF STATEMENT OF REVENUES, EXPENDITURES, AND CHANGES IN FUND BALANCE—GENERAL FUND—TO GOVERNMENT WIDE STATEMENT OF ACTIVITIES FOR THE YEAR ENDED SEPTEMBER 30, 2014

CHANGE IN FUND BALANCE—General Fund	$	(33,280,868)
Amounts reported for governmental activities in the statement of net position are different because:		
Revenues in the statement of activities that do not provide current financial resources are not reported as revenues at the fund level.		
Change in unavailable revenue-TIF		41,066,374
Change in unavailable property taxes		(31,846)
Change in unavailable oil and gas revenue		(10,650)
Change in depreciation		(3,493)
Certain liabilites are not payable from current resources and are therefore not accrued in the fund.		130,487
Certain lease proceeds provide current financial resources to governmental funds, while entering into the leases increases long-term liabilities in the government-wide statement of net position. Repayment of principal is an expenditure in the governmental funds, but the repayment reduces long-term liabilities in the statement of net position.		246,940
This is the amount by which the contributed revenue ($4,648,764) for land exceeded the contributed expenses related to land ($35,406).		4,613,358
The general fund reports capital outlays as expenditures. However, in the statement of activities the cost of those assets is allocated over their estimated useful lives and reported as depreciation expense. This is the amount by which Capital Outlays ($39,365,013) exceeded Depreciation ($2,326,044).		37,038,969
CHANGE IN NET POSITION—Governmental activities	$	49,769,271

The accompanying notes are an integral part of these financial statements.

TARRANT REGIONAL WATER DISTRICT

STATEMENT OF NET POSITION—ENTERPRISE FUND
SEPTEMBER 30, 2014

ASSETS:

Current:		
Cash and cash equivalents	$	26,265,019
Investments		6,997,879
Receivables:		
Accounts and other		1,612,535
Accrued interest		27,775
Prepaid items		2,176,256
Total current assets		37,079,464
Noncurrent:		
Cash and cash equivalents-Bond projects		239,322,955
Investments-Bond projects		388,917,277
Accrued interest receivable-Bond projects		395,809
Cash and cash equivalents-Contingency		1,100,000
Cash and cash equivalents-Restricted for non-current debt service		566,915
Investments-Restricted for non-current debt service		93,736,654
Accrued interest receivable-Restricted for non-current debt service		318,990
Capital Assets:		
Land		133,783,193
Construction in progress		363,799,258
Depreciable capital assets—net		565,222,662
Water rights—net of amortization		492,670
Total noncurrent assets		1,787,656,383
Total assets	$	1,824,735,847

(Continued)

The accompanying notes are an integral part of these financial statements.

TARRANT REGIONAL WATER DISTRICT

STATEMENT OF NET POSITION—ENTERPRISE FUND
SEPTEMBER 30, 2014

LIABILITIES:		
Current Liabilities:		
Accounts payable	$	41,306,018
Due to General Fund		8,538,375
Accrued vacation		580,424
Other liabilities		5,492,290
Payable from restricted assets—accrued bond interest payable		4,911,280
Revenue bonds payable		37,155,000
Notes and interest payable to General Fund		127,568
Total current liabilities		98,110,955
Noncurrent Liabilities:		
Accrued vacation		1,357,284
Long-term post employment benefits		6,454,804
Revenue bonds payable-net of discount		1,343,730,004
Notes and interest payable to General Fund		746,446
Total noncurrent liabilities		1,352,288,538
Total liabilities		1,450,399,493
DEFERRED INFLOWS OF RESOURCES:		
Deferred bond refunding-gain		2,469,138
NET POSITION:		
Net investment in capital assets		308,579,683
Restricted for debt service		90,811,279
Unrestricted		(27,523,746)
TOTAL NET POSITION	$	371,867,216

(Concluded)

The accompanying notes are an integral part of these financial statements.

TARRANT REGIONAL WATER DISTRICT

STATEMENT OF REVENUES, EXPENSES, AND CHANGES IN NET POSITION—ENTERPRISE FUND FOR THE YEAR ENDED SEPTEMBER 30, 2014

OPERATING REVENUES:	
Sale of water	$ 121,710,988
Sale of system capacity	14,072,987
Land lease rentals	88,640
Other	942,094
Total operating revenues	136,814,709
OPERATING EXPENSES:	
General and administrative	27,693,314
Personnel services	11,136,074
Utilities	29,499,922
Depreciation and amortization	16,428,450
Pension plan contribution	1,223,685
Total operating expenses	85,981,445
OPERATING INCOME	50,833,264
NONOPERATING INCOME (EXPENSE):	
Investment income	1,598,019
Interest expense	(18,920,099)
Gain on disposal of capital assets	43,508
Total nonoperating income (expense)	(17,278,572)
NET INCOME	33,554,692
NET POSITION----Beginning of year	338,312,524
NET POSITION—End of year	$ 371,867,216

The accompanying notes are an integral part of these financial statements.

TARRANT REGIONAL WATER DISTRICT

STATEMENT OF CASH FLOWS—ENTERPRISE FUND
FOR THE YEAR ENDED SEPTEMBER 30, 2014

CASH FLOWS FROM OPERATING ACTIVITIES:	
Receipts from customers	$ 135,932,901
Miscellaneous receipts	942,094
Payments to suppliers and contractors	(31,157,899)
Payments to employees for services	(11,571,558)
Payment to General Fund	710,669
Net cash provided by operating activities	94,856,207
CASH FLOWS FROM CAPITAL AND RELATED FINANCING ACTIVITIES:	
Proceeds from the sale of revenue bonds	575,531,337
Principal paid on revenue bonds payable	(30,310,000)
Interest paid on revenue bonds and contract payable	(42,483,045)
Acquisition and construction of capital assets	(150,296,186)
Payments for accrued litigation related to capital assets	(6,175,000)
Cost paid for bond related items	(3,694,052)
Proceeds from disposal of capital assets	43,508
Net cash used for capital and related financing activities	342,616,562
CASH FLOWS FROM INVESTING ACTIVITIES:	
Purchase of investments	(477,700,000)
Proceeds from sale and maturity of investments	156,565,000
Interest received on investments	1,371,522
Net cash provided by investing activities	(319,763,478)
NET DECREASE IN CASH AND CASH EQUIVALENTS	117,709,291
CASH AND CASH EQUIVALENTS—Beginning of year	149,545,598
CASH AND CASH EQUIVALENTS—End of year	$ 267,254,889

(Continued)

The accompanying notes are an integral part of these financial statements.

TARRANT REGIONAL WATER DISTRICT

STATEMENT OF CASH FLOWS—ENTERPRISE FUND
FOR THE YEAR ENDED SEPTEMBER 30, 2014

RECONCILIATION OF OPERATING INCOME TO NET CASH		
PROVIDED BY OPERATING ACTIVITIES:		
Operating income	$	50,833,264
Adjustments to reconcile operating income to net cash provided by operating activities:		
Depreciation & Amortization expense		16,428,450
Write off bad debt expense		5,810,857
Change in assets and liabilities:		
Accounts and other receivables		60,286
Prepaid expenses		(2,173,469)
Accounts payable		19,958,114
Due to (from) other funds—net		811,140
Interfund note payable		(100,471)
Vacation accrual		62,655
OPEB liability		725,546
Other liabilities		2,439,835
Net cash provided by operating activities	$	94,856,207

NONCASH ACTIVITIES:
Disposal of $344,611 of capital assets, net of $334,941 accumulated depreciation.
Capitalization of $21,199,791 of interest on construction projects.
Record change in fair value of investments and change in premium/discounts on investments to interest income of ($422,442) and $209,878 respectively.

(Concluded)

The accompanying notes are an integral part of these financial statements.

TARRANT REGIONAL WATER DISTRICT

STATEMENT OF NET POSITION - FIDUCIARY FUND
FOR THE YEAR ENDED SEPTEMBER 30, 2014

	Other Post-Employment Benefits Trust Fund
ASSETS	
Current assets:	
Cash & cash equivalents	$ 999,864
Total assets	999,864
NET POSITION	
Net assets held in trust for other employee benefits:	
Postemployment healthcare plans	999,864
Total Net Position	$ 999,864

The accompanying notes are an integral part of these financial statements.

TARRANT REGIONAL WATER DISTRICT

STATEMENT OF CHANGES IN NET POSITION - FIDUCIARY FUND
FOR THE YEAR ENDED SEPTEMBER 30, 2014

	Other Post-Employment Benefits Trust Fund
ADDITIONS	
Employer contributions	$ 1,000,000
Total Additions	1,000,000
DEDUCTIONS	
Net gain (loss) in fair value of investments	(136)
Total Deductions	(136)
CHANGE IN NET POSITION	999,864
NET POSITION—Beginning of year	-
NET POSITION—End of year	$ 999,864

The accompanying notes are an integral part of these financial statements.

NOTES TO BASIC FINANCIAL STATEMENTS
AS OF AND FOR THE YEAR ENDED SEPTEMBER 30, 2014

1. SUMMARY OF SIGNIFICANT ACCOUNTING POLICIES

Reporting Entity-The Tarrant Regional Water District (the "District") was created on October 7, 1924 as a municipality with full power to levy ad valorem taxes on all property within the District's boundaries. The District is governed by a board of five directors elected by qualified voters of Tarrant County (the "County") who reside within the District's boundaries. The District was formed to establish a local government agency to provide an adequate supply of raw water to Fort Worth and Tarrant County, Texas. The District also participates in flood control improvement programs, recreation, and has overseen the construction of the Fort Worth Floodway.

The accounting policies of the District conform to accounting principles generally accepted in the United States of America as applicable to governmental units and promulgated by the Governmental Accounting Standards Board ("GASB"). The following is a summary of the more significant policies.

Financial Reporting Entity - In evaluating the District's financial reporting entity, management has considered all potential component units. The following legally separate entity, Trinity River Vision Authority (TRVA), is included as a discrete component unit of the District in a separate column in the government-wide financial statements to emphasize that it is legally separated from the primary government. This component unit has a financial benefit/burden to the District and their relationship with the District is such that exclusion would be misleading. Separately issued financial statements are available for this component unit. Additional financial information regarding the TRVA should be addressed to the Director of Finance, 800 East Northside Drive, Fort Worth, Texas 76102.

Trinity River Vision Authority - House Bill 2639 of the 79th Texas Legislature authorized the Board of Directors of the District to create one or more nonprofit corporations to act on behalf of the District as the District's authority and instrumentality. By resolution dated July 18, 2006, the Board of Directors of the District authorized the incorporation of Trinity River Vision Authority. Subsequently, TRVA was incorporated by the Texas Secretary of State on July 21, 2006 and is governed in part by the Texas Development Corporation Act of 1979 (the "Act"). The TRVA is authorized to act on behalf of the District as the District's authority and instrumentality for the public purposes of educating the general public regarding the Trinity River Vision Project in Fort Worth, Texas, publishing educational materials about said Project, assisting in the coordination and implementation of the Project, and performing such other activities and purposes as permitted by applicable law or authorized by the Board of Directors of TRVA.

Measurement Focus and Basis of Accounting - The District's accounts are organized on the basis of funds, each of which are considered to be a separate accounting entity. The operations of each fund are accounted for by providing a separate set of self-balancing accounts which comprise each fund's assets, liabilities, fund equity, revenues and expenditures, or expenses. The accounting and financial reporting treatment applied to a fund is determined by its measurement focus. The proprietary fund and the government-wide financial statements are

reported using the economic resources measurement focus. The governmental fund financial statements are reported using the current financial resources measurement focus.

Government-wide Financial Statements - Government-wide financial statements consist of the statement of net position and the statement of activities. These statements report information on all of the activities of the District. Eliminations have been made to these statements to prevent double counting of internal activities. Governmental activities, which normally are supported by taxes and intergovernmental revenues, are reported separately from business-type activities, which rely to a significant extent on fees and charges for support.

The statement of activities presents a comparison between direct expenses and program revenues of the business-type activities of the District and for each function of the District's governmental activities. Direct expenses are those that are specifically associated with a program or function and therefore are clearly identifiable to a particular function. Program revenues include charges paid by the recipients of goods or services offered by the programs and grants and contributions that are restricted to meeting the operational or capital requirements of a particular program. Revenues that are not classified as program revenues are presented as general revenues.

The government-wide financial statements are prepared using the economic resources measurement focus and the accrual basis of accounting. Under this measurement focus, revenues are recorded when earned and expenses are recorded at the time the liabilities are incurred, regardless of the timing of cash flows. Property taxes are recognized as revenues in the year for which they are levied. Grants and similar items are recognized as revenue as soon as all eligibility requirements imposed by the provider have been met.

Fund-level Financial Statements - The fund financial statements provide information about the District's individual funds, which are used to account for the District's various activities. Separate financial statements are provided for the General Fund (a governmental fund) and the Enterprise Fund (a proprietary fund), which are each classified as major funds.

Governmental Fund - The General Fund, the only governmental fund reported by the District, is used to account for all financial resources of the District, not specifically levied or collected for other District funds and for revenues and expenditures related to flood control operations and activities or improvements and recreation.

The General Fund is accounted for using the modified accrual basis of accounting. Under the modified accrual basis of accounting, revenues are recognized when susceptible to accrual (i.e., when they become both measurable and available). "Measurable" means the amount of the transaction can be determined and "available" means collectible within the current period or soon enough thereafter to be used to pay liabilities of the current period. The District considers property taxes as available if they are collected within 60 days after year-end. Expenditures are recorded when the related fund liability is incurred.

Governmental funds report unavailable revenue in connection with receivables for revenues that are not considered to be available to liquidate liabilities of the current period. Governmental funds also record unearned revenue in connection with resources that have been received, but not yet earned.

The General Fund is reported using the current financial resources measurement focus. The reported fund balance is considered a measure of "available spending resources". The General Fund operating statement presents increases (revenues and other financing sources) and decreases (expenditures and other financing uses) in net current assets. Accordingly, it is said to present a summary of sources and uses of "available spendable resources" during a period.

Proprietary Fund - The Enterprise Fund, the only proprietary fund reported by the District, is used to account for revenues and expenses relating to maintenance and operation of the water supply system. Currently, the District has outstanding Construction and Improvement Bonds Series 2006 Water Revenue Bonds, Series 2008A-RC Water Revenue Bonds, Series 2008B-CC Water Revenue Bonds, Series 2009 Water Revenue Bonds Refunding and Improvement Bonds, Series 2010 Water Revenue Bonds, Series 2010A Water Revenue Bonds, Series 2010B Water Revenue Bonds, Series 2012 Water Revenue Refunding and Improvement Bonds, Series 2012 Contract Revenue Bond, 2012A Refunding Bond, Series 2014 Water Revenue Bonds, and Series 2014 Contract Revenue Bonds. These bond issues provided funding for large infrastructure-type projects.

Proprietary funds report operations (a) that are financed and operated in a manner similar to private business enterprises where the intent of the governing body is that the costs (expenses, including depreciation) of providing goods or services to the general public on a continuing basis be financed or recovered primarily through user charges; or (b) where the governing body has decided that periodic determination of revenues earned, expenses incurred, and net income is appropriate for capital maintenance, public policy, management control, accountability, or other purposes.

The Enterprise Fund is accounted for using the accrual basis of accounting. Revenues are recognized when earned, and expenses when they are incurred. Claims incurred but not reported are included in payables and expenses.

The Enterprise Fund is reported using an economic resources measurement focus. This means that all assets and liabilities (whether current or noncurrent) associated with the activity are included in the Fund's Statement of Net Position.

Revenues and expenses for the District's Enterprise Fund are categorized as either operating or non-operating. Normally, operating income would exclude from its components those transactions for which cash flows are reported as capital and related financing activities, noncapital financing activities, or investing activities. For the District, operating revenues include sale of water and land lease rentals. Operating expenses include general and administrative, personnel services, utilities, depreciation and amortization, and pension plan contributions.

Fiduciary Fund - The Fiduciary Fund accounts for assets held by the District in a trustee capacity for others or other Funds. The District's only Fiduciary Fund is the Other Employee Benefit Trust Fund which holds assets to be used for the future payments of benefits offered through the District's post-employment healthcare benefit plan. The Fiduciary fund is not included in the government-wide financial statements.

Cash, Cash Equivalents, and Investments - Cash and cash equivalents consist of deposits (principally interest-bearing accounts) with one financial institution and investments in three

public funds investment pools. Investments consist of U.S. Government and government agency obligations recorded at fair value. For accounting purposes, fair value is defined as the price at which two willing parties would complete an exchange.

For purposes of the statement of cash flows, the Enterprise Fund considers all highly liquid (i.e. maturity date of three months or less from the date of purchase) deposits and investments (including restricted assets and the investments in public funds investment pools) to be cash equivalents.

Long Term Receivables - During the fiscal year 2014 the District made expenditures on behalf of the City of Fort Worth Tax Increment Reinvestment Zone #9 (TIRZ) a project partner in the Trinity River Vision (TRV) Project under a Project Cost Funding Agreement between TRWD and Tax Increment Reinvestment Zone #9. Under the agreement TRWD is advancing funds for the TRV Project that would normally be paid by the Tax Increment Reinvestment Zone for costs related to the Project Plan. The Tax Increment Reinvestment Zone currently does not have, and is not projected to have, timely funds to implement the Project Plan as contemplated by the current schedule approved by the USACE. The Tax Increment Reinvestment Zone Board has authorized an agreement with TRWD dedicating revenue from the Tax Increment Reinvestment Zone Fund to cover the advances made by TRWD. The advances must be annually approved by the Tax Increment Reinvestment Zone board and are repayable without interest from future tax revenues of the Tax Increment Reinvestment Zone. During fiscal year 2014, the District expended an additional $44,214,170 under the agreement bringing the total amount expended to $105,955,480; $13,955,764 of that amount has been paid in cash by the Tax Increment Reinvestment Zone, with a remaining outstanding long-term receivable of $91,999,716 as of September 30, 2014. Of the total cash payments from the Tax Increment Reinvestment Zone, $3,147,798 was paid in 2014.

The other large long-term receivable held by the District has been a receivable from Luminant, formerly TXU, which grew to $8.3 million in fiscal year 2014. During the fiscal year Luminant filed for bankruptcy, causing the District to question the collectability of this receivable. As such, the District has written off 100% of the receivable in fiscal year 2014.

Property Taxes - Property subject to taxation is certain real and personal property served by the District in the County. Certain properties of religious, educational, and charitable organizations are exempt from taxation.

The District's ad valorem taxes are levied on October 1, on 100% of assessed valuation at a rate approved by the District's Board per $100 valuation as of the preceding January 1, and are due and payable from October 1 of the year in which levied, until January 31 of the following year without interest or penalty. Taxes paid after February 1 of each year are subject to interest and penalty charges.

In 2014, the District's ad valorem tax rate was $0.02 per $100 valuation. Collections of the current year's levy are reported as current collections if received by June 30 (within 9 months of the October 1 due date). Collections received thereafter are reported as delinquent collections.

Generally, property taxes, net of amounts estimated to be uncollectible, are recorded as a receivable on the assessment date and recognized as revenue when they become available

(collected within 60 days of year-end). The allowance for uncollectible taxes as of September 30, 2014 was $91,924. Under GASB 33, Accounting and Financial Reporting for Non-exchange Transactions, property taxes are imposed non-exchange revenue. Assets from imposed non-exchange transactions are recorded when the entity has enforceable legal claim to the asset, or when the District receives resources, whichever comes first. The assessment date has been designated at a date subsequent to fiscal year-end. The District has not recorded a receivable for accrual of future taxes at year-end because the assessment date had not yet occurred as of fiscal year-end.

The District's taxes on real property are a lien (as of the date of levy) against such property until paid. The District may foreclose on real property upon which it has a lien for unpaid taxes. Delinquent taxes on property not otherwise collected are generally paid when there is a sale or transfer of the title to the property. Any liens and subsequent suits against the taxpayer for payment of delinquent personal property taxes are barred unless instituted within four years from the time such taxes became delinquent.

Oil and Gas Royalties - The District receives royalties related to various oil and gas leases for which the District acts as lessor. The royalties are generally payable to the District when production begins at the lease site, and revenue is recognized as revenue at the time the royalty is earned and considered measurable and available if received within 60 days after year-end.

Capital Assets - Capital assets, which include property, plant, equipment, construction in progress, and infrastructure assets, are reported in the applicable governmental and business-type activities columns in the government-wide financial statements and in the fund financial statements for the Enterprise Fund. The District capitalizes all Machinery and Equipment capital purchases greater than or equal to $10,000 and all other assets purchased which cost $20,000 or greater.

Major outlays for capital assets and improvements are capitalized in the Enterprise Fund as projects are constructed. These costs primarily include construction costs, engineering fees, and legal fees and settlements related to acquisition, condemnation, and mineral rights. Net interest incurred during the construction phase on Enterprise Fund capital assets is capitalized. Total interest capitalized during the year ended September 30, 2014 was $21.2 million.

The costs of repairs and maintenance that do not extend the lives of or improve the value of related capital assets are expensed as incurred.

Depreciation - Depreciation of capital assets is charged as an expense against operations in the applicable governmental and business-type activities columns in the government-wide financial statements and in the fund financial statements for the Enterprise Fund. Capital assets are reported net of accumulated depreciation on the statements of net position. Depreciation is recorded utilizing the straight-line method. Estimated useful lives are as follows:

Dams, spillways, and related costs	50 years
Pipeline and pipeline right-of-way	50 years
Wetlands	50 years
Communications	50 years
Other	50 years
Buildings	20 years
Machinery and equipment	5 years

Deferred Compensation Plan - The District offers its employees a deferred compensation plan created in accordance with Internal Revenue Code Section 457. The plan, available to all District employees at their option, permits participants to defer a portion of their salary until future years. The deferred compensation is not available to participants until termination, retirement, death, or unforeseeable emergency. The assets of this plan are excluded from the District's financial statements.

Water Rights - Water rights represent rights to surplus water in Benbrook Lake purchased in 1992 through a long term contract with the federal government. The rights are recorded at cost and amortized over the 30-year life of the contract using the straight-line method.

Inter-fund Transactions - Certain General Fund expenditures are allocated to the Enterprise Fund. The allocation is based on time and effort for the benefit of the Enterprise Fund by General Fund employees. These allocated expenditures are reflected in the appropriate areas in the accompanying basic financial statements rather than as an inter-fund transaction. At September 30, 2014, the outstanding balance for both loans owed by the Enterprise Fund is $874,014. Refer to Note 8 for further detail about inter-fund transactions.

Pollution Remediation Obligations - The District has an environmental financial obligation for property purchased through September 30, 2014. Properties purchased during fiscal year 2014 were screened for potential environmental concerns based upon available records, assessments and other actions.

The assessments completed to date have found that most of these properties have a low to moderate risk. Currently, six properties, classified as low to moderate risk, have not been fully assessed to determine remediation requirements.

Based upon the Phase I, Phase II, or other site investigations completed to date, nine properties require remediation – eight of those are classified as high or moderate risk, while one is classified as low risk. The anticipated payment of $24.1 million for Pollution Remediation was capitalized on the eight properties that are near enough to the property acquisition date and meet the criteria for capitalization. Pollution remediation was begun on 7 properties, two of which were completed during Fiscal Year 2014. Total Pollution Remediation expenses during the year were $657,036.

Based upon the limited data available, any potential for a liability of the remediation of the remaining other properties cannot be reasonably estimated at this time.

Vacation and Sick Leave - The District's employees are granted paid leave in specified amounts. In the event of termination, an employee is reimbursed for all accumulated unused paid leave. Accrued paid leave is reflected in other liabilities in the accompanying basic financial statements. The change in accrued paid leave during the year is shown below:

	Balance at October 1, 2013	Additions	Deletions	Balance at September 30, 2014	Due Within One Year
Governmental Activities	$ 694,671	$ 199,946	$ 222,410	$ 672,207	$ 201,354
Business-type Activities	1,875,053	703,776	641,121	1,937,708	580,424
Total	$ 2,569,724	$ 903,722	$ 863,531	$ 2,609,915	$ 781,778

Water Revenues - Water rates charged to customers during each year are based on budgeted operating expenses, revenue bond debt service requirements, and estimated customer water usage. Subsequent to year-end, calculations of adjusted water rates based on actual usage and costs are made and either billed or credited to customer accounts as of year-end. While the actual results could differ from the estimate calculated, management normally does not expect the difference to be material to the financial statements. The calculated year-end adjustments for 2014 resulted in an estimated $536,994 due from the customers, which is reflected in the accounts payable balance in the Enterprise Fund. The District has not experienced any credit losses resulting from its sale of water.

Restricted Assets - Certain assets are classified as restricted assets, because their use is limited by applicable bond terms. These assets include amounts restricted for reserve and interest and sinking funds, as required by bond covenants. It also reflects unspent proceeds of revenue bonds.

Program Revenue-Contributions - During 2014 the District received no buy-in premiums for new customer water contracts.

Restricted Net Position - Restricted net position is the restricted assets less the related liabilities.

Budgets and Budgetary Accounting - Budgets are adopted on a basis consistent with accounting principles generally accepted in the United States of America. An annual budget by function is adopted for the General Fund.

Governmental Fund Balances –
Fund Balance Classification – The governmental fund financial statements present fund balances based on classifications that comprise a hierarchy that is based primarily on the extent to which the District is bound to honor constraints on the specific purposes for which amounts in the respective governmental funds can be spent. The classifications used in the governmental fund financial statements are as follows:

Non-Spendable fund balance - Assets that will never convert to cash, such as inventory and prepaid items. At September 30, 2014, the District had non-spendable fund balances in the amount of $3.7 million.

Restricted fund balance - The portion of fund balance that reflects resources that are subject to externally enforceable legal restrictions imposed by parties outside the District at September 30, 2014. At September 30, 2014, the District had no restricted fund balance.

Committed fund balance - The portion of fund balance that reflects resources that can be used only for specific purposes pursuant to constraints imposed by formal action of the Board of Directors. These amounts cannot be used for any other purpose unless the Board of Directors removes or changes the specified use by taking the same type of action (ordinance or resolution) that was employed when the funds were initially committed. At September 30, 2014 the District had no committed fund balance.

Assigned fund balance – The portion of fund balance that reflects resources intended for a specific purpose. Intent is expressed or authorized by Board of Directors.

Unassigned fund balance – The portion of fund balances in excess of non-spendable, restricted, committed, and assigned. This classification includes the residual fund balance for the General Fund of $111.9 million.

Spending Prioritization in Using Available Resources – When both restricted and unrestricted (i.e. committed, assigned, and unassigned) resources are available to be used for the same purpose, the District considers the restricted resources to be expended first. When all categories of unrestricted fund balance are available, the flow assumption is as follows: the committed resources get expended first, the assigned resources get expended second, and the unassigned resources get expended last.

Governmental Accounting Standards Board Statements Implemented in Current Fiscal Year – GASB 66, Technical Corrections; GASB 67, Financial Reporting for Pension Plans; and GASB 70, Accounting and Financial Reporting for Non-exchange Financial Guarantees were implemented with negligible effect on the District's financial statements.

2. REVENUES FROM THE SALE OF WATER

All revenues from the sale of water from Eagle Mountain Lake, Lake Bridgeport, Cedar Creek Lake, and Richland-Chambers Reservoir and related expenses are recorded in the Enterprise Fund.

Sales of water to four government entities (Cities of Fort Worth, Mansfield, and Arlington, and the Trinity River Authority of Texas) accounted for approximately 89% of the District's water sales for the year ended September 30, 2014. Charges to such entities are in amounts primarily equivalent to each entity's share (based on quantities of raw water received) of operating and maintenance costs and the debt service requirements of the District's revenue bonds.

3. CASH, CASH EQUIVALENTS, AND INVESTMENTS

The balance per bank of cash on deposit for the District and the TRVA at September 30, 2014 was $833,557 and $240,159 respectively, and was entirely covered by FDIC insurance or collateral. The carrying value of cash for the District and for TRVA was $791,049 and $228,898 respectively. At September 30, 2014 the District also held petty cash of $1,500.

Credit Risk - Legal provisions of the Texas Public Funds Investment Act generally permit the District to invest in direct and indirect obligations of the United States or its agencies, certain certificates of deposit, repurchase agreements, public funds investment pools, and money market mutual funds.

The District invests in the Texas Local Government Investment Pool ("Texpool"), the Local Government Investment Cooperative ("LOGIC") and Texas Short Term Asset Reserve ("TexSTAR"). Texpool, a public funds investment pool created by the Treasurer of the State of Texas acting by and through the Texas Treasury Safekeeping Trust Company, is empowered to invest funds and act as a custodian of investments purchased with local investment funds.

LOGIC and TexSTAR are also public funds investment pools with the same authority as Texpool. They have been organized and established pursuant to an Interlocal Agreement between participating government entities. The District has an undivided beneficial interest in the pool of assets held by these agencies. These investments and deposits are fully insured by the federal depository insurance or collateralized by securities held in the name of Texas Treasury Safekeeping Trust Company. Authorized investments include obligations of the United States or its agencies, direct obligations of the State of Texas or its agencies, certificates of deposits, and repurchase agreements.

Interest Rate Risk-As a means of limiting its exposure to fair value losses arising from interest rate fluctuations, the District's investment policy limits maturities based on the objectives of each fund. Investment maturities are limited as follows:

General Fund—one to three years

Enterprise Fund:
Revenue sub-fund—six months to one year
Construction sub-fund—determined on a project-by-project basis
Interest and Redemption sub-fund—six months
Reserve sub-fund—not to exceed the date of the District's last maturing revenue bond
Contingency sub-fund—one to three years

Concentration of Credit Risk-The District places no limit on the amount it may invest in one issuer. Approximately 56% of the District's investments are held in Federal Farm Credit Bank, Federal Home Loan Bank, Federal National Mortgage Association and Federal Home Loan Mortgage Corporation.

Custodial Credit Risk-The District's policy requires that all securities be held in the District's name.

Public Funds Investment Act – Audit procedures related to the Public Funds Investment Act are conducted as part of the audit of the basic financial statements disclosed that in the areas of investment practices, management reports and establishment of appropriate policies, the District adheres to the requirements of the Act.

Public Funds Collateral Act – Custodial credit risk is the risk that in the event of bank failure, the District's deposits may not be returned to it. The District has a policy of maintaining contact with the trust department of its depository agency to eliminate all custodial credit risk. As of September 30, 2014, the District's bank balance of $833,557 was not exposed to custodial credit risk and was over-insured and over-collateralized.

SUMMARY OF INVESTMENTS AND CASH EQUIVALENTS AND RELATED WEIGHTED AVG. MATURITY

	Fair Value **	Weighted Avg. Maturity (Years)	S & P Rating
Federal Farm Credit Bank	$ 125,814,581	1.81	AA+ ***
Federal Home Loan Bank	243,515,441	1.75	AA+ ***
Federal Home Loan Mortgage Corp	74,847,662	2.27	AA+ ***
Federal National Mortgage Association	39,328,554	2.39	AA+ ***
U.S. Treasury Notes	61,222,121	1.40	AA+ ***
	544,728,359		
Investment pools:*			
LOGIC****	98,171,461	N/A	AAA-m
TexPool	221,768,245	N/A	AAA-m
TexStar	159,785	N/A	AAA-m
Total investments and cash equivalents	$ 864,827,850		

*Local government pools operate as a money market fund under the Public Funds Investment Act, which requires that it maintain an AAA, AAA-m or equivalent rating from a nationally recognized rating service. Pools are rated AAA-m and operate in full compliance with the PFIA and rating agency requirements. The pools are exempted from SEC registration and the requirements of Rule 2a-7 pertaining to registered money market funds: however, consistent with Rule 2a-7, they seek to maintain a stable net position value of $1 per unit. Investment pools are reported as a part of cash and cash equivalents in the financial statements.

**Fair value is the amount at which a security could be exchanged in a current transaction between willing parties, other than in forced liquidation. Under GASB 31, all investments are recorded at fair value.

***On August 5, 2011 Standard and Poors, one of three nationally recognized raters of U.S. and government sponsored entities debt and securities, downgraded the rating of long-term U.S. sovereign debt from AAA to AA+ for the first time since 1941 with a negative outlook. The two other national raters, Moody's and Fitch, continue to have the highest ratings, but also have the debt on their watch lists.

**** Sandra Newby, Director of Finance, is a member of the LOGIC Board of Directors

4. CAPITAL ASSETS

A summary of changes in capital assets follows:

	October 1, 2013	Additions	Disposals	Transfers	September 30, 2014
GOVERNMENTAL ACTIVITIES					
NONDEPRECIABLE ASSETS					
Land	$ 141,387,171	$ 46,467,607	$ -	$ -	$ 187,854,778
Construction in progress	55,144,489	12,986,996	-	(9,171,360)	58,960,125
TOTAL NONDEPRECIABLE ASSETS	**196,531,660**	**59,454,603**	**-**	**(9,171,360)**	**246,814,903**
DEPRECIABLE ASSETS					
Dams, spillways, and related costs	3,378,736	-	-	-	3,378,736
Flood control projects	8,095,940	-	-	-	8,095,940
Buildings	25,361,800	-	-	9,171,360	34,533,160
Machinery and equipment	10,157,896	1,159,663	(161,829)	-	11,155,730
	46,994,372	1,159,663	(161,829)	9,171,360	57,163,566
Less accumulated depreciation for:					
Dams, spillways, and related costs	(608,937)	(84,198)	-	-	(693,135)
Flood control projects	(8,095,940)	-	-	-	(8,095,940)
Buildings	(6,229,084)	(1,232,119)	-	-	(7,461,203)
Machinery and equipment	(8,213,730)	(720,299)	158,338	-	(8,775,691)
	(23,147,691)	(2,036,616)	158,338	-	(25,025,969)
TOTAL DEPRECIABLE ASSETS, NET	**23,846,681**	**(876,953)**	**(3,491)**	**9,171,360**	**32,137,597**
CAPITAL LEASE DEPRECIABLE ASSETS					
Machinery and equipment	1,447,140	-	-	-	1,447,140
Less accumulated depreciation for:					
Machinery and equipment	(523,579)	(289,428)	-	-	(813,007)
	923,561	**(289,428)**	**-**	**-**	**634,133**
TOTAL GOVERNMENTAL ACTIVITIES, NET	**$ 221,301,902**	**$ 58,288,222**	**$ (3,491)**	**$ -**	**$ 279,586,633**

Depreciation expense was charged to functions of the District as follows:

Governmental activities:	
General government	$ 1,349,578
Flood Control	976,466
Total depreciation expense - governmental activities	$ 2,326,044

	October 1, 2013	Additions	Disposals	Transfers	September 30, 2014
BUSINESS-TYPE ACTIVITIES					
NONDEPRECIABLE ASSETS					
Land	$ 100,739,236	$ 33,044,957	$ (1,000)	$ -	$ 133,783,193
Construction in progress	294,255,165	133,587,472	-	(64,043,379)	363,799,258
TOTAL NONDEPRECIABLE ASSETS	**394,994,401**	**166,632,429**	**(1,000)**	**(64,043,379)**	**497,582,451**
DEPRECIABLE ASSETS					
Dams, spillways, and related costs	210,382,594	-	-	2,547,045	212,929,639
Pipeline and pipeline right of way	507,235,559	-	-	3,055,321	510,290,880
Wetlands	8,823,497	-	-	45,268,105	54,091,602
Communications	1,087,448	-	-	-	1,087,448
Buildings	6,769,080	-	-	47,507	6,816,587
Machinery and equipment	12,714,871	552,134	(344,611)	-	12,922,394
Other project costs	47,648,525	4,322,084	-	13,125,401	65,096,010
	794,661,574	4,874,218	(344,611)	64,043,379	863,234,560
Less accumulated depreciation for:					
Dams, spillways, and related costs	(104,362,228)	(4,146,337)			(108,508,565)
Pipeline and pipeline right of way	(154,103,799)	(9,890,711)			(163,994,510)
Wetlands	(1,814,143)	(169,117)			(1,983,260)
Communications	(221,813)	(20,664)			(242,477)
Buildings	(3,702,635)	(251,973)			(3,954,608)
Machinery and equipment	(10,860,446)	(829,666)	334,941		(11,355,171)
Other project costs	(6,922,879)	(1,050,428)			(7,973,307)
Total accumulated depreciation	(281,987,943)	(16,358,896)	334,941	-	(298,011,898)
TOTAL DEPRECIABLE ASSETS, NET	**512,673,631**	**(11,484,678)**	**(9,670)**	**64,043,379**	**565,222,662**
INTANGIBLE ASSETS					
Water Rights	2,086,598				2,086,598
Less accumulated depreciation for:					
Water Rights	(1,524,375)	(69,553)			(1,593,928)
	562,223	**(69,553)**	**-**	**-**	**492,670**
TOTAL BUSINESS-TYPE ACTIVITIES, NET	**$ 908,230,255**	**$ 155,078,198**	**$ (10,670)**	**$ 0**	**$ 1,063,297,783**

5. PENSION PLAN

Plan Description and Provisions - In 1997, the District adopted a defined contribution benefit plan, the benefits of which depend solely on amounts contributed to the plan plus investment earnings. All full-time employees over the age of 18 are eligible to participate in the plan from the date of employment, and benefits are fully vested at five years of service. Benefit provisions and all other requirements are established by state statute and the District's Board of Directors. The District contributes 13% of each eligible employee's base salary on a monthly basis to the plan's Administrator, ICMA Retirement Trust. Employees may make additional voluntary after tax contributions; however, no employees have contributed to date. District contributions for, and interest forfeited by, employees who leave employment before five years of service are allocated to the other employee accounts. The plan's normal retirement age is 60 years with early retirement eligibility at 55 years of age with five years of service. During 2014 the District made contributions of $2,054,437 under this plan.

6. BONDS PAYABLE

A summary of long-term debt transactions (excluding original issue premiums) of the District for the year ended September 30, 2014 is show below. Bond issuance costs of $3.7 million were expensed this year.

	Balance at October 1, 2013	Additions	Deletions	Balance at September 30, 2014	Due Within One Year
Business-type Activities--- Enterprise Funds-Revenue	$ 802,235,000	$ 520,880,000	$ 30,310,000	$ 1,292,805,000	$ 37,155,000

Bonds Payable-In Fiscal Year 2014, the District issued $318.75 million of Water Revenue Bonds and $202.13 million of Contract Revenue Bonds with Dallas Water Utilities.

Bond Type	Maturity	Interest Rates	Outstanding Balance
Tarrant Regional Water District Projects			
$182,905,000 Series 2006 Water Revenue Bonds	Serially through 2029	4.2 - 5.0%	$182,905,000
$3,135,000 Series 2008A-RC Water Revenue Bonds	Serially through 2027	1.3 - 2.8%	2,770,000
$6,755,000 Series 2008B-CC Water Revenue Bonds	Serially through 2027	2.0 - 2.8%	4,375,000
$69,535,000 Series 2009 Water Revenue Refunding and Improvement Bonds	Serially through 2029	5%	53,845,000
$89,250,000 Series 2010 Water Revenue Bonds	Serially through 2040	4.0 - 5.0%	89,250,000
$17,835,000 Series 2010A Water Revenue Bonds	Serially through 2030	1.2 - 2.6%	17,835,000
$83,785,000 Series 2010B Water Revenue Bonds	Serially through 2030	1.0 - 2.5%	70,790,000
$150,375,000 Series 2012 Water Revenue Bonds	Serially through 2052	2.0 - 5.0%	144,990,000
$98,960,000 Series 2012A Water Revenue Refunding Bonds	Serially through 2022	2.0 - 5.0%	78,690,000
$318,750,000 Series 2014 Water Revenue Bonds	Serially through 2049	4.0 - 5.0%	318,750,000
			964,200,000
TRWD Contract Revenue Bonds (City of Dallas Project)			
$131,935,000 Series 2012 Dallas Contract Revenue Bonds	Serially through 2042	2.0 - 5.0%	126,475,000
$202,130,000 Series 2014 Dallas Contract Revenue Bonds	Serially through 2044	4.0 - 6.0%	202,130,000
			328,605,000
Total-Constuction and Improvement Bonds			1,292,805,000
Less current portion			(37,155,000)
Add premium (net of accumulated amortization)			88,080,004
			$1,343,730,004

In prior years, the District defeased certain revenue and refunding bonds by placing the proceeds of new bonds in an irrevocable trust to provide for all future debt service payments on the old bonds. Accordingly, the trust account assets and the liability for the defeased bonds are not included in the District's financial statements. At September 30, 2014 there are no bonds outstanding that are considered defeased, as all future maturities have been called.

The District amortizes deferred amounts on refunding, including gains and losses, using the straight-line method over the shorter of the remaining life of the old debt or the life of new debt. Premiums on bonds are amortized using the effective interest rate method over the life of the bonds.

The annual requirements to amortize all bonds outstanding as of September 30, 2014 including interest payments are approximately as follows:

Years ending September 30th (in thousands)	Principal	Interest	Requirements
Tarrant Regional Water District Projects			
2015	$ 31,280	$ 42,908	$ 74,188
2016	30,185	41,557	71,742
2017	30,975	40,195	71,170
2018	24,105	39,421	63,526
2019	25,820	38,625	64,445
2020-2024	146,495	176,765	323,260
2025-2029	177,530	142,692	320,222
2030-2034	161,245	103,842	265,087
2035-2039	104,310	69,909	174,219
2040-2044	93,160	46,649	139,809
2045-2049	117,010	20,739	137,749
2050-2054	22,085	1,693	23,778
	964,200	764,995	1,729,195
TRWD Contract Revenue Bonds (City of Dallas Project)			
2015	5,875	15,347	21,222
2016	6,090	15,051	21,141
2017	6,310	14,715	21,025
2018	6,535	14,365	20,900
2019	6,775	14,003	20,778
2020-2024	37,925	64,089	102,014
2025-2029	47,005	54,067	101,072
2030-2034	58,935	43,485	102,420
2035-2039	74,875	28,686	103,561
2040-2044	78,280	10,076	88,356
	328,605	273,884	602,489
Total	$ 1,292,805	$ 1,038,879	$ 2,331,684

Bonded debt of the District consists of water revenue refunding bonds and revenue bonds, which are secured by and payable from net revenues of the District. Certain revenue bond issues contain provisions that allow the District to prepay or call the bonds.

Specifically, net revenues of the District's water operations have been pledged for repayment of the District's revenue bonds. The amount of the pledge is equal to the remaining outstanding debt service requirements for those bonds, which were all originally issued to provide funding for construction of the water system. The pledge continues for the life of the bonds. For the year ended September 30, 2014, pledged revenues for the enterprise fund were $49,181,265.

The various revenue bond indentures contain significant limitations and restrictions on annual debt service requirements, maintenance of and flow of monies through various restricted accounts, and minimum amounts to be maintained in various sinking funds. None of the revenue bond indentures contain bond coverage requirement provisions.

The TRWD Contract Revenue Bonds (City of Dallas Project) are Dallas Water Utilities share of the Integrated Pipeline (IPL) Project, which is currently estimated at $936 million. Under the IPL Project Contract, Dallas has requested and authorized the District to issue contract revenue bonds (the "Dallas Contract Revenue Bonds") secured solely by payments from Dallas to the District under the IPL Project Contract. Such Dallas Contract Revenue Bonds shall be in such amounts and issued at such times as determined by the District, in consultation with Dallas to finance Dallas's share of the design and construction of the IPL project. All such payments by Dallas to the District will constitute operating expenses of the Dallas Water Utilities System. It is currently expected that the District will issue Dallas Contract Revenue Bonds over a 10 to 15 year period to pay Dallas's share of the total capital cost of the IPL project. The District issued the first series of Dallas Contract Revenue Bonds in the principal amount of $131.9 million in February 2012, and the second series of Dallas Contract Revenue bonds in the principal amount of $202.1 million in January 2014. Future Dallas Contract Revenue Bonds will be issued as determined by the District in consultation with Dallas; provided, however, the IPL Project Contract gives the District specific authority to issue Dallas Contract Revenue Bonds without any additional City approval in the event Dallas fails to take certain actions. Dallas's interest in the IPL is not part of the District's System and none of the payments from Dallas to the District under the IPL Project Contract are pledged to the payment of the District's System Revenue Bonds.

7. CAPITAL LEASES

Obligations under a capital lease represent the remaining principal amounts under lease purchase agreements for the acquisition of various computer equipment. These leases are recorded as capital leases in the government-wide reporting. Amortization of the leased assets is included in depreciation expenditures in the government-wide reporting. The leased equipment had an original cost totaling $1.5 million in the General Fund, and $1.2 million in the Enterprise Fund.

The following is a summary of capital lease transactions of the District for the year ended September 30, 2014:

	General Fund	Enterprise Fund
Capital lease obligations, October 1, 2013	$ 735,324	$ 51,616
Less: Principal payments	(246,941)	(51,616)
Add: New Leases	-	-
Capital lease obligations, September 30, 2014	$ 488,383	$ -

The following schedule provides an analysis of the District's investment in capital assets under lease arrangements as of September 30, 2014:

	General Fund	Enterprise Fund
Capital Lease	$ 1,447,140	$ 1,179,654
Less: Accumulated depreciation	(813,007)	(1,047,712)
Total net book value of lease assets	$ 634,133	$ 131,942

Future minimum lease payments for these leases are as follows:

	General Fund		Enterprise Funds	
Year Ending September 30,	Principal Payments	Interest Payments	Principal Payments	Interest Payments
2015	$ 239,242	$ 20,208	$ -	$ -
2016	249,141	10,309	-	-
	$ 488,383	$ 30,517	$ -	$ -

8. INTER-FUND TRANSACTIONS

At September 30, 2014 inter-fund balances consisted of the following:

	Notes & Interest Due From Other Funds	Notes & Interest Due to Other Funds	Due From Other Funds	Due to Other Funds
General Fund	$ 874,014		$ 8,538,375	
Enterprise Fund		$ 874,014		$ 8,538,375
Total	$ 874,014	$ 874,014	$ 8,538,375	$ 8,538,375

The District has two notes between the Enterprise Fund and the General Fund for the reimbursement of a portion of the cost of constructing the administrative building, and the purchase of a helicopter. The administrative building note was set up in 2003; the helicopter note was set up in 2009. During fiscal year 2014, the Enterprise fund repaid $100,471, plus interest of $27,097. At September 30, 2014, the outstanding balance for both loans owed by the Enterprise Fund is $874,014 which is related to its Long-term payable to the General Fund. In the fund financial statements, inter-fund balances (shown as due to/from other funds) are the results of normal expenditure transactions between funds and will be liquidated in the subsequent fiscal year.

All inter-fund receivables and payables are combined in the government-wide financial statement of net position and shown as internal balances.

9. POST EMPLOYMENT HEALTH CARE BENEFITS

Plan Descriptions

The District provides post-employment health care benefits, as established under its Retiree Health Benefits Policy (policy dated January 17, 2006). All retirees who retired prior to the January 1, 2006 policy implementation met the following requirements to continue the health care benefits. The District provides post-retirement health care benefits to all employees who retire from the District at age 55 or after with at least 10 years of continuous full-time employment immediately preceding retirement (and meets the Rule of 80 or Rule of 90). Retirees must also pay a portion (approximately 6%) of the required premiums to carry coverage. During Fiscal Year 2014, twenty-one retirees meet those eligibility requirements and participate in the program. Once an employee or dependent reaches 65 the retiree is eligible for Medicare and the post-employment health care benefits are no longer in effect. The retirees' spouse can continue the post-employment health care benefits for an additional five years after the retiree reaches 65 or until the spouse turns 65, whichever occurs first. The cost of these benefits is recognized as expenditures when the underlying claims or premiums are incurred. During the year ended September 30, 2014, payments of $1,348,797 were recognized for post-retirement health care.

Effective January 1, 2006, Group Health Insurance premiums for retirees are based on the "Rule of 80" or the "Rule of 90". These rules also apply in the event of disability or death while in service.

Rule of 80—the rule of 80 is reached when age and years of service total eighty (80).

If at the time of retirement, the employee meets the "Rule of 80" and elects to continue group health insurance coverage, the District will pay 100% for the premiums for the employee/retiree, the spouse and eligible dependents at the date of retirement. After the initial election, coverage for individuals may be dropped at the time designated by the plan, but no one may be added.

Upon the death of the employee/retiree, the spouse will be covered for an additional five (5) years or until their death, whichever occurs first. Any dependent will be covered as long as they remain eligible under the plan, for five years, or death, whichever comes first.

Rule of 90—the rule of 90 is reached when age and years of service total ninety (90).

If at the time of retirement, the employee meets the "Rule of 90" and elects to continue group health insurance coverage; the District will pay 100% for the single and family premiums for the employee/retiree, the spouse and eligible dependents at the date of retirement. The employee/retiree will be covered until his/her death and the spouse until his/her death, and the

eligible dependents will be covered as long as eligible under the plan or their death, whichever comes first.

All retirees who retired prior to January 1, 2006, and are currently continuing group health insurance coverage through the District will be grand-fathered from this change in policy and will continue paying a flat rate for premiums until their coverage terminates.

While the District does offer this plan to all eligible employees, some retirees elect not to continue the health coverage during their retirement. During Fiscal Year 2014, twenty-one retirees and beneficiaries meet those eligibility requirements. Employees that retired prior to the effective date are not eligible to receive these benefits.

Funding Policies

For other postemployment benefits, contractual requirements for the District are established by the Board of Directors. In Fiscal Year 2014, the District established a trust to fund OPEB costs through Public Agency Retirement Fund (PARS). The District funded the trust with an initial $1 million transfer. In Fiscal Year 2015, another $1 million is budgeted to continue funding the trust. The District continues to pay for a major portion of all of the total health insurance premiums for retirees depending on the retiree's date of employment or length of service and on the retiree's coverage election.

Blended Rate Scenario

The District has established an irrevocable trust and has adopted a funding policy so that the amounts contributed are less than the funding ARC. Under this scenario, GASB 45 requires the use of a discount rate based on a blend of the plan and employer assets. For this valuation, a blended discount rate of 6.20% is assumed. In fiscal year ending September 30, 2014, TRWD contributed $1,000,000 to the OPEB trust. An OPEB trust contribution of $1,663,070 would have satisfied the full funding ARC. Because the additional contribution was 60% of amount required to satisfy the full funding ARC, a blended discount rate based on 60% of the difference between 4.50% and 7.30% was chosen. This blended discount rate has caused a $10.4 million decrease in the Actuarial Accrued Liability (AAL) estimate over what the AAL would have been using the old 4.50% discount rate.

Annual OPEB Costs

The District's annual other post-employment benefits (OPEB) cost is calculated based on the annual required contribution of the employer (ARC), an amount actuarially determined in accordance with the parameter of GASB Statement No. 45. The ARC represents a level of accrual that is projected to recognize the normal cost each year and to amortize any unfunded actuarial liabilities (or funding excess) over a period not to exceed thirty years. The annual OPEB cost for the fiscal year ended September 30, 2014, is as follows:

	2013	2014
Annual required contribution	$ 2,778,216	$ 2,234,270
Interest on OPEB obligation	292,592	545,458
Adjustment to ARC	(271,084)	(454,767)
Annual OPEB cost (expense)	2,799,724	2,324,961
Contributions made	(504,072)	(1,348,750)
Increase in net OPEB obligation	2,295,652	976,211
Net OPEB obligation--as of beginning of the year	6,502,051	8,797,703
Net OPEB obligation--as of end of year	$ 8,797,703	$ 9,773,914
Percentage of annual OPEB cost contributed	18.0%	58.0%

At September 30, 2014, the total liability of $9,773,914 for Net OPEB obligation was $3,319,110 for governmental activities and $6,454,804 for business-type activities.

The District's annual OPEB cost, the percentage of annual OPEB cost contributed to the plan, and the net OPEB obligation for the past three years follows:

Fiscal Year Ended	Annual OPEB Cost	Employer Contribution	Annual OPEB Cost Contributed	Net OPEB Obligation
9/30/2012	$ 2,239,521	$ 525,879	23.5%	$ 6,502,051
9/30/2013	$ 2,799,724	$ 504,072	18.0%	$ 8,797,703
9/30/2014	$ 2,324,961	$1,348,750	58.0%	$ 9,773,914

Funding Status and Funding Progress

The funded status of the District's retiree health care plan, under GASB Statement No. 45 as of December 31, 2011 is as follows:

Actuarial accrued liability (a)	$	28,791,154
Actuarial value of plan assets (b)		-
Unfunded actuarial accrued liability (a-b)		28,791,154
Funded ratio (b) / (a)		0%
Covered payroll (c)	$	13,624,301
Unfunded actuarial accrued liability as a percentage of covered payroll ((a – b) / c)		211%

Under the reporting parameters, as of December 31, 2011 the District's retiree health care plan was 0.0% funded with an estimated actuarial accrued liability exceeding actuarial assets by $28,791,154. The ratio of the unfunded actuarial accrued liability to annual covered payroll was 211%.

Actuarial Methods and Assumptions

The Entry Age Normal actuarial cost method is used to calculate the GASB ARC for the District's retiree health care plan. Using the plan benefits, the present health premiums and a set of actuarial assumptions, the anticipated future payments are projected. The entry age normal method then provides for a systematic recognition of the cost of these anticipated payments. The yearly ARC is computed to cover the cost of benefits being earned by covered members as well as to amortize a portion of the unfunded accrued liability.

Projections of health benefits are based on the plan as understood by the District and include the types of benefits in force at the valuation date and the pattern of sharing benefit costs between the District and its employees to that point. Actuarial calculations reflect a long-term perspective and employ methods and assumptions that are designed to reduce short-term volatility in actuarial accrued liabilities and the actuarial value of assets. Significant methods and assumptions were as follows:

Actuarial Methods and Assumptions

Inflation rate	3.0% per annum
Investment rate of return	6.2%, net of expenses
Actuarial Cost Method	Entry Age Normal Cost Method
Amortization method	Level as a Percentage of Employee Payroll
Amortization period	30-year Open Amortization
Payroll Growth	3.0% per annum
Healthcare Cost Trend Rate	Initial Rate of 8.5% Declining to an Ultimate Rate of 4.5% after 8 years

Actuarial valuations involve estimates of the value of reported amounts and assumptions about the probability of events in the future. Amounts determined regarding the funded status and the annual required contributions of the District's retiree health care plan are subject to continual revision as actual results are compared to past expectations and new estimates are made about the future. The required schedule of funding progress presented as required supplementary information provides multiyear trend information that shows whether the actuarial value of plan assets is increasing or decreasing over time relative to the actuarial accrued liability for benefits.

10. COMMITMENTS AND CONTINGENCIES

Commitments-the Enterprise and General Fund have remaining commitments estimated at $135.1 million ($131.7 million and $3.4 million respectively) due to on-going construction contracts as of September 30, 2014.

Contingent Liabilities - The District is involved in lawsuits arising in the ordinary course of business, including claims involving water and mineral rights, contract disputes, and alleged property damages. Certain amounts have been accrued for potential losses. It is management's opinion that outstanding claims would not have a material effect on the District's operations.

Insurance - The District has employee blanket bond insurance. The District also participates in a public entity risk pool for its fleet policy, property insurance, workers' compensation, general liability, and director/officer liability coverage. For the IPL project the District, along with the City of Dallas, is utilizing a Rolling Owner Controlled Insurance Program (ROCIP).

For the public entity risk pool, in the event of an occurrence, wrongful act, or personal injury, written notice containing particulars of the incident or injury shall be promptly provided to the Texas Water Conservation Association Risk Management Fund (the "Trust"). If a claim is made or a suit is brought against the District, the District shall immediately forward to the Trust every demand, notice, summons, or other process received. The District shall cooperate with the Trust and give any information as may be reasonably required, and upon the Trust's request, assist in making settlement, in the conduct of suits and in enforcing any right of contribution or indemnity against any person or organization who may be liable to the District because of injury or damage with respect to which insurance is afforded under the agreement. The District shall attend hearings and trials and assist in securing and giving evidence and obtaining the attendance of witnesses. The District shall not, except at its own cost, voluntarily make any payment, assume any obligation, or incur any expense that could increase the liability, exposure of, or jeopardize the Trust in any way.

The Trust will pay on behalf of the District all sums that the District shall become legally obligated to pay arising out of an occurrence that takes place during the Trust year and within the agreement. The Trust reserves the right to deny any and all claims that are not reported.

The Trust shall have the right and the duty to defend any suit against the District, even if the allegations of the suit are groundless, false or fraudulent, and may make such investigation and settlement of any claim or suit it deems expedient, but the Trust shall not be obliged to pay any claim or judgment, or to defend a suit, after the applicable limit of the Trust's liability has been exhausted.

Any settlement amounts paid within the past three years have not exceeded the District's insurance coverage.

The IPL Rolling Owner Controlled Insurance Program (ROCIP) program is a master insurance, safety, and claims management program that provides specific coverages for Workers' Compensation, Employers Liability, Commercial General Liability, and Excess Liability for the Owner and all Enrolled Participants on the IPL.

In the event of an occurrence, wrongful act, or personal injury, all participants in the ROCIP program must promptly provide written notice to Willis of Texas, the ROCIP Administrator, per contract agreement. The ROCIP Administrator will check the information for accuracy and promptly report the claim to the Insurance Provider. The Insurance Provider will coordinate the investigation of commercial general liability claims. Contractor's team members are required to cooperate with the Insurance Provider's investigations. A per occurrence deductible of $5,000 will be paid by the enrolled participant.

Notifications of a lawsuit or litigation are made to the PCM and ROCIP Administrator and shall be by email or telephone immediately when served with notice of any lawsuits or citations filed against either Enrolled Participants or Excluded Participants. Failure to respond to a lawsuit within the prescribed time may result in a default judgment. The entity served with the lawsuit will pay judgments and expenses associated with a default judgment. Enrolled participants must initially report all workers' compensation claims to the ROCIP Administrator. Claims must be reported no later than the end of the shift during which the accident occurred except in cases of serious injuries which shall be reported immediately. The Insurance Provider will coordinate the investigations of all workers' compensation claims.

The ROCIP provides builders risk coverage for all enrolled participants. The coverage includes all materials and equipment that will be permanently incorporated into the project including property in-transit and stored at pre-approved locations. Enrolled participants are responsible for the first $25,000 of any loss.

At this time there are no losses to report.

Arbitrage Rebate Liability - The excess profit earned from investing the proceeds of tax-exempt bonds at a yield that is materially higher than the yield on the bonds. Excess earnings are required to be rebated every five years or upon maturity of the bonds, whichever is earlier. The District has no arbitrage rebate liability as of September 30, 2014.

11. RECENTLY ISSUED GASB STATEMENTS

The GASB has issued a number of standards that will become effective for the District in future years.

GASB Statement No. 68: Accounting and Financial Reporting for Pensions - was also issued in June 2012 and establishes accounting and financial reporting requirements related to pensions for governments whose employees are provided with pensions through pension plans, as well as for nonemployer governments that have a legal obligation to contribute to those plans. This statement requires the recognition of the entire net pension liability and a more comprehensive measure of pension expense, along with additional required footnote disclosures. This standard becomes effective for the District in fiscal year 2015 but is not applicable to the District practices.

GASB Statement No. 69: Government Combinations and Disposals of Government Operations - was issued in January 2013 and establishes accounting and financial reporting standards for government combinations and disposals of government operations. This statement distinguishes between government mergers and acquisitions and provides guidance on the appropriate accounting treatment of each. This Statement also provides guidance for transfers of operations that do not constitute entire legally separate entities and in which no significant consideration is exchanged. GASB 69 becomes for the District in fiscal year 2015, and should be applied on a prospective basis.

GASB Statement No. 71: Pension Transition for Contributions Made Subsequent to the Measurement Date—an amendment of GASB Statement No. 68 - was issued in November 2013 and addresses the transition provisions of GASB Statement No. 68, *Accounting and Financial Reporting for Pensions*. GASB 71 eliminates a potential source of understatement of restated beginning net position and expense in a government's first year of implementing GASB Statement No. 68. This statement becomes effective for the District in fiscal year 2015.

COMPONENT UNIT

The following notes are for the District's component unit, Trinity River Vision Authority, which are not duplicated by the notes of the District.

12. SUMMARY OF SIGNIFICANT ACCOUNTING POLICIES FOR TRVA

Reporting Entity - by resolution dated July 18, 2006, the Board of Directors of the Tarrant Regional Water District (the "District") authorized the incorporation of the Trinity River Vision Authority (TRVA). Subsequently, TRVA was incorporated by the Texas Secretary of State on July 21, 2006 and is governed, in part, by the Texas Development Corporation Act of 1979 (the "Act"). The TRVA is authorized to act on behalf of the District and the District's authority and instrumentality for the public purposes of educating the general public regarding the **Trinity River Vision Project** in Fort Worth, Texas, publishing educational materials about said Project, assisting in the coordination and implementation of the Project, and performing such other activities and purposes as permitted by applicable law or authorized by the Board of Directors of TRVA.

The accounting policies of the TRVA conform to accounting principles generally accepted in the United States of America as applicable to governmental units and promulgated by the Governmental Accounting Standards Board (GASB). The following is a summary of the more significant policies.

Financial Reporting Entity-TRVA is included as a discrete component unit in the financial statements of the District.

Cash and Cash Equivalents-cash and cash equivalents are considered to be cash on hand, demand deposits and short-term investments with maturities of three months or less. Cash and cash equivalents for fiscal year 2014 cash and cash equivalents consist of deposits (principally interest-bearing accounts) with one financial institution and in a public funds investment pool.

Capital Assets-capital assets of TRVA are transferred to the District or the City of Forth Worth upon completion. Construction in Progress is recorded for any capital assets not completed as of year-end.

Budgets and Budgetary Accounting-budgets are adopted on a basis consistent with accounting principles generally accepted in the United States of America. An annual budget is adopted for the General Fund.

13. CASH AND CASH EQUIVALENTS FOR TRVA

The balance per bank of cash on deposit at September 30, 2014 was $240,159 and was entirely covered by FDIC insurance. The carrying value for TRVA was $228,898 as of September 30, 2014.

Legal provisions generally permit TRVA to invest in direct and indirect obligations of the United States or its agencies, certain certificates of deposit, repurchase agreements, public funds investment pools, and mutual funds. During the year ended September 30, 2014, TRVA did not own any types of securities other than those permitted by statute. The TRVA invests in the Texas Local Government Investment Pool ("TexPool"). TexPool is a public fund investment pool created by the Treasurer of the State of Texas acting by and through the Texas Treasury Safekeeping Trust Company, is empowered to invest funds and act as a custodian of investments purchased with local investment funds. It has been organized and established pursuant to an Interlocal Agreement between participating government entities. TRVA has an undivided beneficial interest in the pool of assets held by this agency. These investments and deposits are fully insured by federal depository insurance or collateralized by securities held in the name of Texas Treasury Safekeeping Company, the entity that created TexPool. Authorized investments include obligations of the United States or its agencies, direct obligations of the State of Texas or its agencies (TexPool only), certificates of deposit, and repurchase agreements. TRVA's balance in TexPool as of September 30, 2014 was $2.7 million.

Interest Rate Risk-as a means of limiting its exposure to fair value losses arising from interest rate fluctuations, TRVA's investment policy limits maturities to a maximum of three years.

Concentration of Credit Risk-TRVA places no limit on the amount the TRVA may invest in one issuer. All investments at September 30, 2014 were in TexPool.

Custodial Credit Risk-TRVA policy requires that all securities be held in TRVA's name.

SUMMARY OF INVESTMENTS AND RELATED WEIGHTED AVERAGE MATURITY

	Fair Value **	Weighted Avg. Maturity (Years)	S & P Rating
Investment Pools*			
Texpool	$ 2,707,322	N/A	AAA-m
Total investments	$ 2,707,322		

*Local government pools operate as a money market fund under the Public Funds Investment Act, which requires that it maintain an AAA, AAA-m or equivalent rating from a nationally recognized rating service. Pools are rated AAA-m and operate in full compliance with the PFIA and rating agency requirements. The pools are exempted from SEC registration pertaining to registered money market funds; however, they seek to maintain a stable net position value of $1 per unit.

**Fair value is the amount at which a security could be exchanged in a current transaction between willing parties, other than in forced liquidation. All investments are recorded at fair value.

14. CAPITAL ASSETS FOR TRVA

A summary of changes in capital assets follows:

	October 1, 2013	Additions	Disposals	Transfers	September 30, 2014
Construction in progress	$ 1,660,976	$ 4,161	$ (1,665,137)	$ -	$ -
TOTAL NONDEPRECIABLE ASSETS	**1,660,976**	**4,161**	(1,665,137)	-	-
TOTAL CAPITAL ASSETS	**$ 1,660,976**	**$ 4,161**	**$ (1,665,137)**	**$ -**	**$ -**

Upon completion of the design phase of the White Settlement Bridge and local street modifications, the asset was contributed to the Texas Department of Transportation.

15. COMMITMENTS AND CONTINGENCIES FOR TRVA

Insurance-the TRVA has employee blanket bond insurance. The TRVA also participates in a public entity risk pool for its general liability, automotive reliability, and errors and omissions liability coverage. The TRVA has such insurance coverage as an additional insured on a policy issued to the Tarrant Regional Water District through the Texas Water Conservation Association Risk Management Fund (the "Trust"). The general policy conditions provide as follows:

In the event of an occurrence, wrongful act, or personal injury, written notice containing particulars of the incident or injury shall be promptly provided to the Trust. If a claim is made or a suit is brought against the TRVA, the TRVA shall immediately forward to the Trust every demand, notice, summons, or other processes received. TRVA shall cooperate with the Trust and give any information as may be reasonably required, and upon the Trust's request, assist in making settlement, in the conduct of suits and in enforcing any right of contribution or indemnity against any person or organization who may be liable to the TRVA because of injury or damage with respect to which insurance is afforded under the agreement. The TRVA shall attend hearings and trials and assist in securing and giving evidence and obtaining the attendance of witnesses. The TRVA shall not, except at its own cost, voluntarily make any payment, assume any obligation, or incur any expense that could increase the liability exposure of, or jeopardize the Trust in any way.

The Trust will pay on behalf of the TRVA all sums that TRVA shall become legally obligated to pay arising out of an occurrence that takes place during the Trust year and within the agreement. The Trust reserves the right to deny any and all claims that are not reported. The Trust shall have the right and the duty to defend any suit against the TRVA, even if the allegations of the suit are groundless, false or fraudulent, and may make such investigation and settlement of any claim or suit it deems expedient, but the Trust shall not be obligated to pay any claim or

judgment, or to defend a suit, after the applicable limit of the Trust's liability has been exhausted.

As of September 30, 2014, there were no settlements paid from the insurance coverage on behalf of the TRVA.

REQUIRED SUPPLEMENTARY INFORMATION (UNAUDITED)

TARRANT REGIONAL WATER DISTRICT

SCHEDULE OF REVENUES, EXPENDITURES, AND CHANGES IN FUND BALANCE—BUDGET TO ACTUAL—GAAP BASIS—GENERAL FUND (UNAUDITED)
FOR THE YEAR ENDED SEPTEMBER 30, 2014

	Original and Final Budget	Actual
REVENUES:		
Property taxes	$ 8,600,000	$ 9,263,039
Lease rentals	1,266,200	1,314,725
Oil and gas royalties	20,000,000	24,518,478
Sale of rock and gravel	12,500	12,500
Investment income	575,000	367,655
Contributions	300,000	3,386,255
Other	145,300	311,573
Total revenues	30,899,000	39,174,225
EXPENDITURES		
Current:		
General and administrative	9,608,964	9,043,006
Personnel services	4,984,379	4,821,935
Pension plan contribution	571,765	512,818
Contributions to component unit	40,000	18,434,944
Capital expenditures	65,200,000	39,365,013
Capital lease payment	278,000	277,377
Total expenditures	80,683,108	72,455,093
CHANGE IN FUND BALANCE	(49,784,108)	(33,280,868)
FUND BALANCE—Beginning of year	148,953,824	148,953,824
FUND BALANCE—End of year	$ 99,169,716	$ 115,672,956

Note to RSI

Excess of Contributions to Component Unit over Budget - for year ended September 30, 2014, the $18.4 million contribution made to TxDOT related to the construction of the three bridges was not budgeted for in the Contributions to Component Unit line item.

TARRANT REGIONAL WATER DISTRICT
SCHEDULE OF FUNDING PROGRESS AND EMPLOYER CONTRIBUTIONS
OTHER POSTEMPLOYMENT BENEFITS (UNAUDITED)
FOR THE YEAR ENDED SEPTEMBER 30, 2014

Valuation Date	Actuarial Value of Assets (AVA)	Actuarial Accrued Liability (AAL)	Unfunded Actuarial Accrued Liability (UAAL)	Funded Ratio	Annual Covered Payroll	UAAL as % of Payroll
	(a)	**(b)**	**(b-a)**	**(a/b)**	**(c)**	**((b-a)/c)**
12/31/2007	$ -	$ 25,092,209	$ 25,092,209	0%	$ 9,372,400	268%
12/31/2009	$ -	$ 31,676,995	$ 31,676,995	0%	$ 11,489,400	276%
12/31/2011	$ -	$ 39,215,923	$ 39,215,923	0%	$ 13,624,301	288%
12/31/2011*	$ -	$ 28,791,154	$ 28,791,154	0%	$ 13,624,301	211%

* The recalculated 12/31/2011 AAL reflects a change in the discout rate from 4.50% to 6.20%.

OTHER SUPPLEMENTARY INFORMATION (UNAUDITED)

TARRANT REGIONAL WATER DISTRICT

SCHEDULE OF BONDS AUTHORIZED, ISSUED, AND OUTSTANDING BY PURPOSE OF ISSUE
AS OF SEPTEMBER 30, 2014 (UNAUDITED)

	Year Authorized	Issued Amount	Outstanding
Construction and improvement bonds:			
Tarrant Regional Water District Projects			
Water Revenue Bonds - Series 2006	2006	$ 182,905,000	$ 182,905,000
Water Revenue Bonds - Series 2008A-RC	2008A	3,135,000	2,770,000
Water Revenue Bonds - Series 2008B-CC	2008B	6,755,000	4,375,000
Water Revenue Refunding and Improvement Bond - Series 2009	2009	69,535,000	53,845,000
Water Revenue Bonds - Series 2010	2010	89,250,000	89,250,000
Water Revenue Bonds - Series 2010A	2010	17,835,000	17,835,000
Water Revenue Bonds - Series 2010B	2010	83,785,000	70,790,000
Water Revenue Bonds - Series 2012	2012	150,375,000	144,990,000
Water Revenue Refunding Bonds - Series 2012A	2013	98,960,000	78,690,000
Water Revenue Bonds - Series 2014	2014	318,750,000	318,750,000
		1,021,285,000	964,200,000
TRWD Contract Revenue Bonds (City of Dallas Project)			
Contract Revenue Bonds (City of Dallas Project) - Series 2012	2012	131,935,000	126,475,000
Contract Revenue Bonds (City of Dallas Project) - Series 2014	2014	202,130,000	202,130,000
		334,065,000	328,605,000
Total - Construction and improvement bonds		$ 1,355,350,000	$ 1,292,805,000

Note: Above amounts exclude unamortized original issue premiums.

TARRANT REGIONAL WATER DISTRICT

SCHEDULE OF CHANGES IN BONDED DEBT
FOR THE YEAR ENDED SEPTEMBER 30, 2014 (UNAUDITED)

	Balance October 1, 2013	Total Issued	Total Retired	Balance September 30, 2014
Tarrant Regional Water District Projects				
Water Revenue Bonds —series 2006	$ 182,905,000			$ 182,905,000
Water Revenue Bonds —series 2008A-RC	2,955,000		$ 185,000	2,770,000
Water Revenue Bonds —series 2008B-CC	4,375,000			4,375,000
Water Revenue Refunding and Improvement —series 2009	53,845,000			53,845,000
Water Revenue Bonds —series 2010	89,250,000			89,250,000
Water Revenue Bonds —series 2010A	17,835,000			17,835,000
Water Revenue Bonds —series 2010B	74,185,000		3,395,000	70,790,000
Water Revenue Bonds —series 2012	150,375,000		5,385,000	144,990,000
Water Revenue Refunding Bonds —series 2012A	97,275,000		18,585,000	78,690,000
Water Revenue Bonds —series 2014	-	$ 318,750,000		318,750,000
	673,000,000	318,750,000	27,550,000	964,200,000
TRWD Contract Revenue Bonds (City of Dallas Project)				
Contract Revenue Bonds (City of Dallas Project) —series 2012	129,235,000		2,760,000	126,475,000
Contract Revenue Bonds (City of Dallas Project) —series 2014	-	202,130,000		202,130,000
	129,235,000	202,130,000	2,760,000	328,605,000
Total	$ 802,235,000	$ 520,880,000	$ 30,310,000	$ 1,292,805,000

Note: Above amounts exclude unamortized original issue premiums.

TARRANT REGIONAL WATER DISTRICT

GENERAL GOVERNMENTAL EXPENDITURES BY FUNCTION (1)
LAST 10 FISCAL YEARS (UNAUDITED)

Fiscal Year	Administrative		Maintenance and Warehouse	Tax Assessing and Collecting
2005	$ 4,379,995		$ 3,831,855	$ 157,413
2006	4,921,537		4,214,926	168,843
2007	11,468,757	(2)	4,638,174	177,719
2008	10,761,691		5,152,642	188,141
2009	9,916,759		5,041,273	223,329
2010	7,464,592		5,802,893	268,144
2011	5,870,935	(3)	5,993,362	262,644
2012	7,395,829		5,998,138	259,615
2013	8,227,077		6,551,189	377,099
2014	25,429,379	(4)	6,901,056	482,268

(1) Includes General Fund expenditures but excludes capital expenditures and depreciation expense.

(2) Increase is related to an increase in contributions to the Trinity River Vision Project.

(3) Decrease due to more expenses being allocated to the Enterprise Fund due to the large bond projects.

(4) Increase is related to an increase in contributions to the Trinity River Vision Project, largely due to the $18.4 million contribution to Texas Department of Transportation for the bridges.

TARRANT REGIONAL WATER DISTRICT

ENTERPRISE FUND EXPENSES
LAST 10 FISCAL YEARS (UNAUDITED)

Fiscal Year	Operating Maintenance and Administrative		Interest Expense		Depreciation and Amortization
2005	$ 21,663,253		$ 11,403,366		$ 10,272,674
2006	41,458,563	(1)	14,830,399		10,179,471
2007	31,468,193		16,072,941		10,206,921
2008	33,107,306		10,823,849		11,798,556
2009	37,456,752		19,423,791		15,284,771
2010	33,748,148		19,714,313		15,663,973
2011	41,441,508	(1)	19,140,654		16,174,207
2012	46,127,011	(1)	19,238,227		16,656,082
2013	55,653,489	(1)	14,938,583	(2)	16,573,425
2014	69,552,995	(1)	18,920,099	(3)	16,428,450

(1) Increase due to an increase in pumping power costs due to the drought conditions.

(2) Decrease in interest expense due to refunding of the 2002 Bond Issuance.

(3) Increase in interest expense due to issuance of 2014 Bonds.

TARRANT REGIONAL WATER DISTRICT

GENERAL GOVERNMENTAL REVENUES BY SOURCE
LAST 10 FISCAL YEARS (UNAUDITED)

Fiscal Year	Oil and Gas Royalties		Land Lease Rentals	Interest Income	Transfer/ Other		Property Taxes
2005	$ 23,472,113		$ 250,076	$ 968,967	$ 538,454		$ 5,959,884
2006	28,800,533		257,644	2,684,659	1,419,866	(1)	6,561,859
2007	34,007,763		370,305	4,455,483	6,278,019		7,322,427
2008	68,057,516	(2)	348,619	4,100,005	5,328,653		8,056,037
2009	34,397,855		327,741	3,137,581	2,469,605		8,735,179
2010	34,354,862		656,328	1,468,495	603,740	(3)	9,002,136
2011	27,777,427	(4)	662,857	1,045,664	1,466,505		8,600,104
2012	20,738,333	(4)	875,426	708,010	9,042,451	(5)	8,857,981
2013	31,367,889	(6)	1,385,702	300,771	4,345,035	(5)	8,993,946
2014	24,518,478	(4)	1,314,725	367,655	3,710,328	(5)	9,263,039

(1) As of 2006 transfers were included in this total.

(2) The District entered into new oil and gas leases which included significant bonus payments and operating royalties.

(3) As of 2010 interfund revenue was not included in the number, it was treated as a contra expense.

(4) Oil and gas royalties are reflective of a down market as well as a reduced number of bonus payment

(5) In 2012 $8.0 million was received under the Project Cost Fund agreement between TRWD and TIF, in 2013 $2.8 million was received from the TIF, and in 2014 $3.1 million was received from the TIF.

(6) Oil and gas royalties increased due to an increase in production, increased market prices, and the collection of back royalties due to the Oil and Gas third party audit.

TARRANT REGIONAL WATER DISTRICT

ENTERPRISE FUND REVENUES
LAST 10 FISCAL YEARS (UNAUDITED)

Fiscal Year	Sale of Water		Investment Income		Land Lease Rentals	Other (1)	
2005	$60,126,522		$ 1,868,698		$ 109,233	$ 1,321,587	
2006	80,343,028		6,716,967		55,109	1,462,521	
2007	73,740,294		10,613,665		99,728	976,123	
2008	66,486,843		4,550,301	(2)	77,933	1,667,723	
2009	80,469,426		3,486,297		67,692	318,089	
2010	79,465,525		2,969,407		78,480	290,656	
2011	90,310,650	(3)	1,873,044		79,586	1,512,159	(4)
2012	98,844,939	(3)	2,183,834		76,624	650,548	
2013	120,043,265	(3)	262,520		85,681	1,129,678	
2014	135,783,975	(3)	1,598,019		88,640	985,602	

(1) Other revenues include contributions, gains on sale of investments and property, plant and equipment, and buy-in premiums.

(2) Decrease due to large down turn in bonds market.

(3) Increase in water sales due to system costs related to debt service and pumping power.

(4) Increase in 2011 due to cost reimbursement from Dallas Water Utilities.

TARRANT REGIONAL WATER DISTRICT

PROPERTY TAX LEVIES AND COLLECTIONS
LAST 10 FISCAL YEARS (UNAUDITED)

Fiscal Year	Total Tax Levy	Current Tax Collections	Ratio of Current Tax Collections to Total Tax Levy	Delinquent Tax Collections	Ratio of Delinquent Tax Collections to Total Tax Levy	Total Tax Collections	Ratio of Total Tax Collections to Total Tax Levy
2005	$ 5,955,710	$ 5,857,339	98.3%	$ 102,545	1.72%	$ 5,959,884	100.1%
2006	6,523,826	6,482,144	99.4%	109,990	1.69%	6,592,134	101.0%
2007	7,301,143	7,226,033	99.0%	96,394	1.32%	7,322,427	100.3%
2008	8,006,321	7,972,642	99.6%	96,975	1.21%	8,069,617	100.8%
2009	8,692,629	8,576,152	98.7%	62,858	0.72%	8,639,010	99.4%
2010	8,961,076	8,836,802	98.6%	112,749	1.26%	8,949,551	99.9%
2011	8,585,136	8,461,681	98.6%	71,226	0.83%	8,532,907	99.4%
2012	8,778,407	8,664,270	98.7%	112,467	1.28%	8,776,737	100.0%
2013	8,934,929	8,820,523	98.7%	111,025	1.24%	8,931,548	100.0%
2014	9,192,432	9,083,100	98.8%	94,414	1.03%	9,177,514	99.8%

TARRANT REGIONAL WATER DISTRICT

ASSESSED AND ACTUAL ESTIMATED VALUE OF PROPERTY
LAST 10 FISCAL YEARS (UNAUDITED)

Fiscal Year	Assessed Valuation	Estimated Actual Valuation	Ratio of Assessed Valuation to Estimated Actual Valuation
2005	$ 29,337,958,539	$ 29,778,521,629	98.5%
2006	31,686,327,914	31,760,084,866	99.8%
2007	36,055,574,973	36,506,443,351	98.8%
2008	40,031,703,354	39,887,627,798	100.4%
2009	43,463,173,474	41,425,734,107	104.9%
2010	44,802,386,393	42,709,872,649	104.9%
2011	42,636,798,867	42,925,679,331	99.3%
2012	43,715,648,106	43,892,079,947	99.6%
2013	44,476,657,492	44,674,429,572	99.6%
2014	45,346,218,693	45,962,219,088	98.7%

Note: All taxes are recorded in the General Fund.

TARRANT REGIONAL WATER DISTRICT
ENTERPRISE FUND DEBT SERVICE REQUIREMENTS TO MATURITY (IN THOUSANDS) 2014 (UNAUDITED)
TARRANT REGIONAL WATER DISTRICT PROJECT

YR	2006 - Water Revenue			2008A WIF			2008B WIF			2009 - Water Revenue			2010 - Water System			2010 A - Series 2010A			2010 B - Series 2010B			2012 - Refunding and			2012A - Refunding			2014 - Revenue Bonds			Total Enterprise Funds		
	Princ.	Int.	Total	Princ.	Int.	Total	Princ.	Int.	Total	Princ.	Int.	Total	Princ.	Int.	Total	Princ.	Int.	Total	Princ.	Int.	Total	Princ.	Int.	Total	Princ.	Int.	Total	Princ.	Int.	Total	Princ.	Int.	Total
2015	$	8,530	8,530	$ 185	65	250				$	2,692	2,692	$	4,153	4,153				$ 3,500	1,253	4,753	$ 5,660	6,998	12,658	$ 19,445	3,365	22,810	$ 2,490	15,852	18,342	$ 31,280	42,908	74,188
2016		8,530	8,530	190	61	251					2,692	2,692		4,153	4,153				3,605	1,243	4,848	5,950	6,708	12,658	20,440	2,368	22,808		15,802	15,802	30,185	41,557	71,742
2017		8,530	8,530	195	58	253					2,692	2,692		4,153	4,153				3,715	1,220	4,935	6,100	6,407	12,507	20,965	1,333	22,298		15,802	15,802	30,975	40,195	71,170
2018	8,700	8,347	17,047	195	54	249	$ 605	100	705	3,360	2,608	5,968	2,120	4,106	6,226	$ 1,305	243	1,548	3,830	1,186	5,016	735	6,247	6,982	3,255	728	3,983		15,802	15,802	24,105	39,421	63,526
2019	9,080	7,969	17,049	200	50	250	620	87	707	3,530	2,436	5,966	2,230	4,008	6,238	1,160	352	1,512	3,945	1,144	5,089	750	6,228	6,978	3,410	572	3,982	895	15,779	16,674	25,820	38,625	64,445
2020	9,480	7,568	17,048	205	46	251	630	73	703	3,710	2,255	5,965	2,345	3,899	6,244	1,200	335	1,535	4,065	1,091	5,156	770	6,209	6,979	3,555	427	3,982	1,405	15,722	17,127	27,365	37,625	64,990
2021	9,905	7,145	17,050	210	40	250	645	58	703	3,900	2,065	5,965	2,465	3,779	6,244	1,235	314	1,549	4,190	1,026	5,216	790	6,190	6,980	3,720	263	3,983	805	15,667	16,472	27,865	36,547	64,412
2022	10,350	6,701	17,051	215	35	250	665	41	706	4,100	1,865	5,965	2,590	3,653	6,243	1,270	291	1,561	4,315	951	5,266	815	6,166	6,981	3,900	85	3,985	1,125	15,624	16,749	29,345	35,412	64,757
2023	16,690	6,102	22,792	220	30	250	680	23	703	4,315	1,654	5,969	2,720	3,520	6,240	1,310	264	1,574	4,450	868	5,318		6,154	6,154					15,602	15,602	30,385	34,217	64,602
2024	17,450	5,342	22,792	225	23	248	530	7	537	4,535	1,433	5,968	2,860	3,395	6,255	1,350	236	1,586	4,585	776	5,361		6,153	6,153					15,602	15,602	31,535	32,967	64,502
2025	18,300	4,496	22,796	235	17	252				4,765	1,201	5,966	3,010	3,277	6,287	1,390	207	1,597	4,725	676	5,401		6,154	6,154					15,602	15,602	32,425	31,630	64,055
2026	19,235	3,558	22,793	240	11	251				5,010	956	5,966	3,160	3,138	6,298	1,435	174	1,609	4,865	569	5,434		6,153	6,153					15,602	15,602	33,945	30,161	64,106
2027	20,220	2,572	22,792	255	4	259				5,265	699	5,964	3,325	2,976	6,301	1,475	139	1,614	5,015	454	5,469		6,154	6,154					15,602	15,602	35,555	28,600	64,155
2028	21,230	1,562	22,792							5,535	429	5,964	3,495	2,805	6,300	1,520	102	1,622	5,170	331	5,501		6,153	6,153					15,602	15,602	36,950	26,984	63,934
2029	22,265	529	22,794							5,820	146	5,966	3,675	2,626	6,301	1,570	62	1,632	5,325	202	5,527		6,154	6,154					15,602	15,602	38,655	25,321	63,976
2030													3,865	2,438	6,303	1,615	21	1,636	5,490	68	5,558		6,153	6,153				18,735	15,133	33,868	29,705	23,813	53,518
2031													4,060	2,255	6,315							6,450	5,992	12,442				20,355	14,156	34,511	30,865	22,403	53,268
2032													4,270	2,062	6,332							6,750	5,671	12,421				21,145	13,118	34,263	32,165	20,851	53,016
2033													4,490	1,857	6,347							7,065	5,334	12,399				21,980	12,040	34,020	33,535	19,231	52,766
2034													4,720	1,652	6,372							7,375	4,973	12,348				22,880	10,919	33,799	34,975	17,544	52,519
2035													4,960	1,434	6,394							7,725	4,596	12,321				9,495	10,109	19,604	22,180	16,139	38,319
2036													5,215	1,205	6,420							8,070	4,201	12,271				9,980	9,623	19,603	23,265	15,029	38,294
2037													5,480	965	6,445							8,445	3,788	12,233				10,490	9,111	19,601	24,415	13,864	38,279
2038													5,765	708	6,473								3,577	3,577				11,030	8,573	19,603	16,795	12,858	29,653
2039													6,060	435	6,495								3,577	3,577				11,595	8,007	19,602	17,655	12,019	29,674
2040													6,370	147	6,517								3,577	3,577				12,190	7,413	19,603	18,560	11,137	29,697
2041																						4,460	3,466	7,926				12,815	6,787	19,602	17,275	10,253	27,528
2042																						4,690	3,237	7,927				13,470	6,130	19,600	18,160	9,367	27,527
2043																						4,930	2,996	7,926				14,160	5,440	19,600	19,090	8,436	27,526
2044																						5,185	2,743	7,928				14,890	4,713	19,603	20,075	7,456	27,531
2045																						5,450	2,478	7,928				15,650	3,950	19,600	21,100	6,428	27,528
2046																						5,730	2,198	7,928				16,455	3,147	19,602	22,185	5,345	27,530
2047																						6,025	1,904	7,929				17,330	2,303	19,633	23,355	4,207	27,562
2048																						6,330	1,595	7,925				18,220	1,414	19,634	24,550	3,009	27,559
2049																						6,655	1,271	7,926				19,165	479	19,644	25,820	1,750	27,570
2050																						6,995	929	7,924							6,995	929	7,924
2051																						7,355	571	7,926							7,355	571	7,926
2052																						7,735	193	7,928							7,735	193	7,928
	$ 182,905	87,481	270,386	$ 2,770	494	3,264	$ 4,375	389	4,764	$ 53,845	25,823	79,668	89,250	68,799	158,049	17,835	2,740	20,575	70,790	13,058	83,848	$ 144,990	169,248	314,238	$ 78,690	9,141	87,831	$ 318,750	387,829	706,579	$ 964,200	765,002	1,729,202

TARRANT REGIONAL WATER DISTRICT

ENTERPRISE FUND DEBT SERVICE REQUIREMENTS TO MATURITY (IN THOUSANDS) 2014 (UNAUI

TRWD CONTRACT REVENUE BONDS (CITY OF DALLAS PROJECT)

	Dallas 2012 - Series 2012			Dallas 2014 - Series 2014			Total Contract Revenue		
YR	Princ.	Int.	Total	Princ.	Int.	Total	Princ.	Int.	Total
2015	2,835	5,066	7,901	3,040	10,281	13,321	5,875	15,347	21,222
2016	2,895	4,953	7,848	3,195	10,098	13,293	6,090	15,051	21,141
2017	2,955	4,808	7,763	3,355	9,907	13,262	6,310	14,715	21,025
2018	3,015	4,660	7,675	3,520	9,705	13,225	6,535	14,365	20,900
2019	3,075	4,509	7,584	3,700	9,494	13,194	6,775	14,003	20,778
2020	3,140	4,356	7,496	3,885	9,272	13,157	7,025	13,628	20,653
2021	3,200	4,199	7,399	4,075	9,039	13,114	7,275	13,238	20,513
2022	3,270	4,039	7,309	4,280	8,795	13,075	7,550	12,834	20,384
2023	3,345	3,875	7,220	4,495	8,538	13,033	7,840	12,413	20,253
2024	3,515	3,708	7,223	4,720	8,268	12,988	8,235	11,976	20,211
2025	3,620	3,602	7,222	4,955	7,985	12,940	8,575	11,587	20,162
2026	3,765	3,458	7,223	5,205	7,688	12,893	8,970	11,146	20,116
2027	3,920	3,307	7,227	5,465	7,479	12,944	9,385	10,786	20,171
2028	4,075	3,189	7,264	5,735	7,261	12,996	9,810	10,450	20,260
2029	4,240	3,067	7,307	6,025	7,031	13,056	10,265	10,098	20,363
2030	4,415	2,940	7,355	6,325	6,730	13,055	10,740	9,670	20,410
2031	4,595	2,808	7,403	6,640	6,414	13,054	11,235	9,222	20,457
2032	4,780	2,664	7,444	6,975	6,082	13,057	11,755	8,746	20,501
2033	4,970	2,473	7,443	7,320	5,733	13,053	12,290	8,206	20,496
2034	5,225	2,274	7,499	7,690	5,367	13,057	12,915	7,641	20,556
2035	5,485	2,065	7,550	8,075	4,982	13,057	13,560	7,047	20,607
2036	5,765	1,846	7,611	8,475	4,579	13,054	14,240	6,425	20,665
2037	6,055	1,615	7,670	8,900	4,155	13,055	14,955	5,770	20,725
2038	6,360	1,373	7,733	9,345	3,710	13,055	15,705	5,083	20,788
2039	6,605	1,118	7,723	9,810	3,243	13,053	16,415	4,361	20,776
2040	6,855	854	7,709	10,300	2,752	13,052	17,155	3,606	20,761
2041	7,115	580	7,695	10,815	2,237	13,052	17,930	2,817	20,747
2042	7,385	295	7,680	11,360	1,697	13,057	18,745	1,992	20,737
2043				11,925	1,129	13,054	11,925	1,129	13,054
2044				12,525	532	13,057	12,525	532	13,057
	$ 126,475	83,701	210,176	$ 202,130	190,183	392,313	$ 328,605	273,884	602,489

TARRANT REGIONAL WATER DISTRICT

MISCELLANEOUS STATISTICAL FACTS
AS OF SEPTEMBER 30, 2014 (UNAUDITED)

Date of organization	October 7, 1924
Area covered by District	345 square miles
Facilities:	
Number of water supply reservoirs	4

	Conservation Pool	Actual in Storage
Acre feet of water storage:		
Bridgeport Lake	366,236	200,516
Eagle Mountain Lake	182,505	135,340
Cedar Creek Lake	644,785	488,901
Richland Chambers	1,137,204	801,209
Total	2,330,730	1,625,966

Miles of levees	23
Miles of floodway river channel	27
Area to be maintained by District	1,997 acres
Employees:	
Administrative and office	139
Maintenance	105

Annual rainfall in inches—last 10 calendar years:

Year	DFW Weather Service	Lake Worth	Eagle Mountain Lake	Bridgeport Lake	Cedar Creek Lake	Richland/ Chambers
2004	47.57	42.55	50.61	33.78	40.96	41.51
2005	18.97	13.69	17.62	11.51	20.07	19.42
2006	29.75	26.60	23.56	27.95	26.90	29.18
2007	50.05	40.88	45.06	36.80	51.94	53.56
2008	27.10	27.09	27.39	25.58	26.30	30.09
2009	40.89	31.48	27.86	33.20	43.23	54.54
2010	37.55	32.46	34.93	36.01	24.83	38.68
2011	25.88	17.94	20.67	25.13	22.56	30.79
2012	31.26	25.18	24.32	23.32	30.06	30.83
2013	29.40	24.28	25.18	24.70	24.82	34.82

TARRANT REGIONAL WATER DISTRICT

SCHEDULE OF INSURANCE
AS OF SEPTEMBER 30, 2014 (UNAUDITED)

Insurer	Policy Period	Type of Coverage	Limits
Hartford Insurance Co. [1]	03/29/14–03/29/15 03/29/13–03/29/14	Crime	$500,000—liability
	01/15/13-until canceled	Director Bond	$10,000—per director
TWCA Risk Management Fund [2]	07/01/13–07/01/14 07/01/14–07/01/15	Fleet Policy	$10,000,000—liability
	07/01/13–07/01/14 07/01/14–07/01/15	Property Insurance	$260,552,875—blanket limit $287,580,288—blanket limit
	07/01/13–07/01/14 07/01/14–07/01/15	Workers' Compensation	Statutory limits
	07/01/13–07/01/14 07/01/14–07/01/15	General Liability	$10,000,000—limit
	07/01/13–07/01/14 07/01/14–07/01/15	Errors and Omissions Liability	$10,000,000—limit
	07/01/13–07/01/14	Rental Coverage [3]	$250,000—limit
Blue Cross Blue Shield of Texas	01/01/14–12/31/15	Health Insurance	Unlimited per employee
Sutton James Insurance Broker	12/15/12-12/15/13 12/16/13-12/16/14	Aviation Coverage	$370,000—Physical Damage $5,000,000—Liability
Willis of Texas, Inc. [4]	07/01/13–07/01/14 07/01/14–07/01/15	Rolling Owner Controlled Insurance Program - IPL	$1,000,000 —Commercial General Liability $1,000,000 —Automobile Liability

[1] This is a pool administered by J. I. Specialty Services.

[2] This is a pool through the Texas Water Conservation Association Risk Management Fund administered by J. I. Specialty Services.

[3] As of 7/2/14, the District has elected to forego Rental Reimbursement Coverage.

[4] Willis of Texas is the broker/administrator who supports the self-insurance held on the IPL project

The District has paid all premiums due prior to September 30, 2014.

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Tarrant Regional Water District
Quarterly Financial Report
For the Quarter Ended

March 31, 2015

Tarrant Regional Water District
Budget vs. Actual

TARRANT REGIONAL WATER DISTRICT

STATEMENT OF NET POSITION
MARCH 31, 2015

	Primary Government			
	Governmental Activities	Business-Type Activities	Total	Component Unit
ASSETS:				
Cash and cash equivalents	$ 59,345,103	$ 12,399,872	$ 71,744,975	$ 2,243,370
Investments	47,135,959	6,002,601	53,138,560	
Receivables:				
Accounts, oil and gas royalties, and other	3,356,382	1,074,541	4,430,923	105,490
Accrued interest	100,101	28,292	128,393	
Long-term receivable	103,865,439		103,865,439	
Internal balances	6,684,174	(6,684,174)	-	
Prepaid items	3,252,642	12,595,837	15,848,479	13,439
Inventory of supplies-at cost	54,573		54,573	
Cash and cash equivalents for bond projects		138,529,032	138,529,032	
Investments held for bond projects		371,098,644	371,098,644	
Accrued interest receivable for bond projects		373,959	373,959	
Cash and cash equivalents restricted		1,100,000	1,100,000	
Cash and cash equivalents for debt service		10,941,353	10,941,353	
Investments restricted for debt service		83,731,706	83,731,706	
Accrued interest receivable restricted for debt service		243,661	243,661	
Land	196,196,422	137,036,480	333,232,902	
Construction in progress	60,520,733	445,165,697	505,686,430	
Depreciable capital assets, net of accumulated depreciation	32,817,580	565,604,666	598,422,246	
Water rights, net of amortization		492,670	492,670	
Total Assets	513,329,108	1,779,734,837	2,293,063,945	2,362,299
DEFERRED OUTFLOWS OF RESOURCES:				
Deferred bond refunding-loss			-	
LIABILITIES:				
Accounts payable	3,148,195	2,810,262	5,958,457	384,238
Accrued vacation - due within one year	201,354	580,424	781,778	
Other liabilities	2,064,305	9,406,730	11,471,035	2,594,972
Payable from restricted assets - Accrued bond interest payable		5,438,833	5,438,833	
Revenue bonds payable, net of discount				
Due within one year		36,820,000	36,820,000	
Due in more than one year		1,319,088,187	1,319,088,187	
Long-term Payables				
Long-term arbitrage rebate payable		-	-	
Accrued Litigation Judgements			-	
Pollution Remediation Obligations	20,346,110		20,346,110	
Post employment benefits payable	3,319,110	6,454,804	9,773,914	
Accrued Vacation - due in more than one year	470,853	1,357,284	1,828,137	
Total Liabilities	29,549,927	1,381,956,524	1,411,506,451	2,979,210
DEFERRED INFLOWS OF RESOURCES:				
Deferred bond refunding-gain		4,569,061	4,569,061	
NET POSITION:				
Net investment in capital assets	289,534,735	297,823,900	587,358,635	-
Restricted for debt service		90,577,887	90,577,887	-
Unrestricted	194,244,446	4,807,465	199,051,911	(616,911)
Total Net Position	$ 483,779,181	$ 393,209,252	$ 876,988,433	$ (616,911)

TARRANT REGIONAL WATER DISTRICT

STATEMENT OF ACTIVITIES
FOR THE QUARTER ENDED MARCH 31, 2015

Functions/Programs	Expenses	Program Revenues: Charges for services	Program Revenues: Capital Grants and Contributions	Net (Expense) Revenue and Changes in Net Position: Primary Government: Governmental Activities	Primary Government: Business Type Activities	Primary Government: Total	Component Unit
PRIMARY GOVERNMENT							
Governmental activities:							
General government	$ 5,076,819	$ 10,519,686	$ 11,865,723	$ 17,308,590		$ 17,308,590	
Flood control	2,108,220			(2,108,220)		(2,108,220)	
Total governmental activities	7,185,039	10,519,686	11,865,723	15,200,370		15,200,370	
Business type activities-water supply	55,928,480	74,284,057			$ 18,355,577	18,355,577	
TOTAL	$ 63,113,519	$ 84,803,743	$ 11,865,723	$ 15,200,370	$ 18,355,577	$ 33,555,947	
COMPONENT UNIT							
Trinity River Vision Authority							
Project Development	10,271,458	9,573,851					$ (697,607)
Recreation Programs	173,450	191,928	35,500				53,978
Total Component Unit	$ 10,444,908	$ 9,765,779	$ 35,500				$ (643,629)
GENERAL REVENUES (EXPENSES):							
Property taxes				9,128,054	-	9,128,054	
Investment income				275,443	2,321,258	2,596,701	279
Miscellaneous				32,649	637,958	670,607	2,100
Gain/loss on disposal of assets				44,752	27,243	71,995	
Total general revenues and transfers				9,480,898	2,986,459	12,467,357	2,379
CHANGES IN NET POSITION				24,681,268	21,342,036	46,023,304	(641,250)
NET POSITION-----Beginning of year				459,097,913	371,867,216	830,965,129	24,339
NET POSITION-----March 31, 2015				$ 483,779,181	$ 393,209,252	$ 876,988,433	$ (616,911)

TARRANT REGIONAL WATER DISTRICT

BALANCE SHEET—GENERAL FUND
MARCH 31, 2015

ASSETS		
CASH AND CASH EQUIVALENTS	$	59,345,103
INVESTMENTS		47,135,959
RECEIVABLES:		
Oil and gas royalties and other		3,356,382
Accrued interest		100,101
DUE FROM ENTERPRISE FUND		5,913,235
NOTES AND INTEREST DUE FROM ENTERPRISE FUND		770,939
PREPAID ITEMS		3,252,642
INVENTORY OF SUPPLIES—At cost		54,573
LONG-TERM RECEIVABLE		103,865,439
TOTAL ASSETS	$	223,794,373
LIABILITIES:		
ACCOUNTS PAYABLE	$	3,148,195
OTHER LIABLITIES		1,575,922
TOTAL LIABILITIES		4,724,117
DEFERRED INFLOWS:		
UNAVAILABLE REVENUE		103,865,439
TOTAL DEFERRED INFLOWS		103,865,439
FUND BALANCES:		
Nonspendable:		
Long-term interfund notes and interest		770,939
Prepaid items		3,252,642
Inventory of supplies - At cost		54,573
Unassigned		111,126,663
Total fund balances		115,204,817
TOTAL	$	223,794,373

RECONCILIATION OF BALANCE SHEET-GENERAL FUND TO GOVERNMENT-WIDE STATEMENT OF NET POSITION
MARCH 31, 2015

TOTAL FUND BALANCES—General Fund	$115,204,817
Amounts reported for governmental activities in the statement of net position are different because:	
Certain revenues do not provide current financial resources and are therefore are unavailable at the fund level	
TIF loan long term receivable	103,865,439
Certain liabilities are not payable from current resources and are therefore not accrued at the fund level	(24,337,427)
Certain leases are not due and payable in the current period and therefore are not reported as liablities to governmental funds.	(488,383)
Captial assets used in governmental activities are not financial resources and therefore are not reported as assets in governmental funds	289,534,735
TOTAL NET POSITION—Governmental activities	$483,779,181

TARRANT REGIONAL WATER DISTRICT

STATEMENT OF REVENUES, EXPENDITURES, AND CHANGES IN FUND BALANCES—GENERAL FUND

FOR THE QUARTER ENDED MARCH 31, 2015

REVENUES:		
Property taxes	$	9,140,050
Lease rentals		1,223,165
Oil and gas royalties		9,584,992
Investment income		275,443
Other		204,651
Total revenues		20,428,301
EXPENDITURES:		
Current:		
General and administrative		5,789,069
Personnel services		2,383,025
Pension plan contribution		259,113
Capital expenditures		12,465,233
Total expenditures		20,896,440
DEFICIENCY OF REVENUES UNDER EXPENDITURES		(468,139)
CHANGE IN FUND BALANCES		(468,139)
FUND BALANCES—Beginning of year		115,672,956
FUND BALANCES—March 31, 2015	$	115,204,817

TARRANT REGIONAL WATER DISTRICT

RECONCILIATION OF STATEMENT OF REVENUES, EXPENDITURES, AND CHANGES IN FUND BALANCES--GENERAL FUND--TO GOVERNMENT WIDE STATEMENT OF ACTIVITIES FOR THE QUARTER ENDED MARCH 31, 2015

CHANGE IN FUND BALANCES—General Fund	($468,139)
Amounts reported for governmental activities in the statement of net position are different because:	
Revenues in the statement of activities that do not provide current financial resources are not reported as revenues in the fund.	
Change in unavailable revenue-TIF	11,865,723
Change in unavailable property taxes	(11,996)
Change in unavailable oil and gas revenue	(415,721)
Certain liabilities are not paybale from current resources and are therefore not accrued in the fund.	1,246,168
The general fund reports capital outlays as expenditures. However, in the statement of activities the cost of those assets is allocated over their estimated useful lives and reported as depreciation expense. This is the amount by which capital outlays exceed expenditures.	12,465,233
CHANGE IN NET POSITION—Governmental activities	$24,681,268

TARRANT REGIONAL WATER DISTRICT

STATEMENT OF NET POSITION—ENTERPRISE FUND
MARCH 31, 2015

ASSETS:

Current:		
Cash and cash equivalents	$	12,399,872
Investments		6,002,601
Receivables:		
Accounts and other		1,074,541
Accrued interest		28,292
Prepaid items		12,595,837
Total current assets		32,101,143
Noncurrent:		
Cash and cash equivalents-Bond projects		138,529,032
Investments-Bond projects		371,098,644
Accrued interest receivable-Bond projects		373,959
Cash and cash equivalents-Contingency		1,100,000
Cash and cash equivalents-Restricted for non-current debt service		10,941,353
Investments-Restricted for non-current debt service		83,731,706
Accrued interest receivable-Restricted for non-current debt service		243,661
Capital Assets:		
Land		137,036,480
Construction in progress		445,165,697
Depreciable capital assets—net		565,604,666
Water rights—net of amortization		492,670
Total noncurrent assets		1,754,317,868
Total assets	$	1,786,419,011

DEFERRED OUTFLOWS OF RESOURCES:

Deferred bond refunding-loss		-

(Continued)

TARRANT REGIONAL WATER DISTRICT

STATEMENT OF NET POSITION—ENTERPRISE FUND
MARCH 31, 2015

LIABILITIES:		
Current Liabilities:		
Accounts payable	$	2,810,262
Due to General Fund		5,913,235
Accrued vacation		580,424
Other liabilities		9,406,730
Payable from restricted assets—accrued bond interest payable		5,438,833
Revenue bonds payable		36,820,000
Notes and interest payable to General Fund		127,568
Total current liabilities		61,097,052
Noncurrent Liabilities:		
Accrued vacation		1,357,284
Long-term post employment benefits		6,454,804
Revenue bonds payable—net of discount		1,319,088,187
Notes and interest payable to General Fund		643,371
Total noncurrent liabilities		1,327,543,646
Total liabilities		1,388,640,698
DEFERRED INFLOWS OF RESOURCES:		
Deferred bond refunding-gain		4,569,061
NET POSITION:		
Net investment in capital assets		297,823,900
Restricted for debt service		90,577,887
Unrestricted		4,807,465
TOTAL NET POSITION	$	393,209,252

(Concluded)

TARRANT REGIONAL WATER DISTRICT

STATEMENT OF REVENUES, EXPENSES, AND CHANGES IN NET POSITION—ENTERPRISE FUND FOR THE QUARTER ENDED MARCH 31, 2015

OPERATING REVENUES:		
Sale of water	$	63,518,545
Sale of System Capacity		10,610,903
Land lease rentals		26,710
Sale of power		9,912
Other		755,945
Total operating revenues		74,922,015
OPERATING EXPENSES:		
General and administrative		8,600,239
Personnel services		5,597,063
Utilities		11,094,862
Pension plan contribution		616,586
Total operating expenses		25,908,750
OPERATING INCOME		49,013,265
NONOPERATING INCOME (EXPENSE):		
Investment income		2,321,258
Interest expense		(30,019,730)
Gain on disposal of capital assets		27,243
Total nonoperating income (expense)		(27,671,229)
NET INCOME		21,342,036
NET POSITION—Beginning of year		371,867,216
NET POSITION—March 31, 2015	$	393,209,252

TARRANT REGIONAL WATER DISTRICT

STATEMENT OF NET POSITION - FIDUCIARY FUND
FOR THE QUARTER ENDED MARCH 31, 2015

	Other Post-Employment Benefits Trust Fund
ASSETS	
Current assets:	
Cash & cash equivalents	$ 2,040,120
Total assets	2,040,120
NET POSITION	
Net assets held in trust for other employee benefits:	
Postemployment healthcare plans	2,040,120
Total Net Position	$ 2,040,120

TARRANT REGIONAL WATER DISTRICT

STATEMENT OF CHANGES IN NET POSITION - FIDUCIARY FUND
FOR THE QUARTER ENDED MARCH 31, 2015

	Other Post-Employment Benefits Trust Fund
ADDITIONS	
Employer contributions	$ 1,000,000
Net gain (loss) in fair value of investments	43,960
Total Additions	1,043,960
DEDUCTIONS	
Admininstrative expenses	3,704
Total Deductions	3,704
CHANGE IN NET POSITION	1,040,256
NET POSITION—Beginning of year	999,864
NET POSITION—End of year	$ 2,040,120

TARRANT REGIONAL WATER DISTRICT
Notes to the Quarterly Financial Report
March 31, 2015

NOTE 1 - The total column on the Combined Balance Sheet is presented only to facilitate financial analysis. Data in this column does not present financial position, results of operations or changes in financial position in conformity with generally accepted accounting principles. Neither is such data comparable to consolidation. Inter-fund eliminations have not been made in the aggregation of this data.

NOTE 2 - At March 31, 2015, the District's long term debt consisted of:

	ENTERPRISE
Tarrant Regional Water District Projects	
Series 2008A Richland Chambers Wetlands Bonds	2,585,000
Series 2008B Cedar Creek Wetlands Bonds	4,375,000
Series 2009 Water Revenue Bonds	53,845,000
Series 2010 Water Revenue Bonds	89,250,000
Series 2010 TWDB-A Bonds	17,835,000
Series 2010 TWDB-B Bonds	67,290,000
Series 2012 Water Revenue Bonds	139,330,000
Series 2012A Water Revenue Bonds	59,245,000
Series 2014 Water Revenue Bonds	316,260,000
Series 2015 Water Revenue Bonds	156,470,000
	906,485,000
TRWD Contract Revenue Bonds (City of Dallas Project)	
Series 2012 Dallas Water Revenue Bonds	126,475,000
Series 2014 Dallas Water Revenue Bonds	202,130,000
	328,605,000
Total-Construction and Improvements Bonds	1,235,090,000
ADD: Gain/Loss Refunding	4,569,061
ADD: Premium, net of accumulated amortization	120,818,187
	$1,360,477,248

NOTE 2 - Continued

Rollforward of Bonds Payable
Enterprise Fund

BONDS PAYABLE	BONDS PAYABLE BALANCE 9/30/2014	ACTIVITY	BONDS PAYABLE BALANCE 3/31/2015
Tarrant Regional Water District Projects			
Series 2006	182,905,000	(182,905,000)	0
Unamortized Premium	2,099,923	(2,099,923)	0
Gain/Loss Refunding	0	0	0
Series 2008A	2,770,000	(185,000)	2,585,000
Unamortized Premium	0	0	0
Gain/Loss Refunding	0	0	0
Series 2008B	4,375,000	0	4,375,000
Unamortized Premium	0	0	0
Gain/Loss Refunding	0	0	0
Series 2009	53,845,000	0	53,845,000
Unamortized Premium	2,576,085	0	2,576,085
Gain/Loss Refunding of 1999 Series	0	0	0
Series 2010	89,250,000	0	89,250,000
Unamortized Premium	2,335,863	0	2,335,863
Gain/Loss Refunding	0	0	0
Series 2010 TWDB-A	17,835,000	0	17,835,000
Unamortized Premium	0	0	0
Gain/Loss Refunding	0	0	0
Series 2010 TWDB-B	70,790,000	(3,500,000)	67,290,000
Unamortized Premium	0	0	0
Gain/Loss Refunding	0	0	0
Series 2012	144,990,000	(5,660,000)	139,330,000
Unamortized Premium	15,038,380	0	15,038,380
Gain/Loss Refunding of 1993 Series	0	0	0
Gain/Loss Refunding of 2002 Series	988,821	0	988,821
Series 2012A	78,690,000	(19,445,000)	59,245,000
Unamortized Premium	6,840,823	0	6,840,823
Gain/Loss Refunding of 1993 Series	0	0	0
Gain/Loss Refunding of 2002 Series	1,480,317	0	1,480,317
Series 2014	318,750,000	(2,490,000)	316,260,000
Unamortized Premium	28,778,326	0	28,778,326
Gain/Loss Refunding	0	0	0
Series 2012	0	156,470,000	156,470,000
Unamortized Premium	0	34,838,106	34,838,106
Gain/Loss Refunding of 2006 Series	0	2,099,923	2,099,923
	$1,024,338,538	$ (22,876,894.00)	$1,001,461,644
TRWD Contract Revenue Bonds (City of Dallas Project)			
Series 2012 Dallas	126,475,000	0	126,475,000
Unamortized Premium	6,036,146	0	6,036,146
Gain/Loss Refunding	0	0	0
Series 2014 Dallas	202,130,000	0	202,130,000
Unamortized Premium	24,374,458	0	24,374,458
Gain/Loss Refunding	0	0	0
	$359,015,604	$0	$359,015,604
Total-Construction and Improvement Bonds	$1,383,354,142	$ (22,876,894.00)	$1,360,477,248

NOTE 3 - At March 31, 2015, the District's Enterprise Fund Property, Plant and Equipment consisted of:

	REVENUE	CONSTRUCTION	TOTAL
Property, Plant & Equipment	$99,631,126	$1,346,119,283	$1,445,750,409
LESS: Accumulated Depreciation	79,651,105	218,292,461	297,943,566
TOTAL	$19,980,021	$1,127,826,822	$1,147,806,843

P or C #49 B
TRWD (DWU)

9/30/2015

Dallas Bonds

Dates	2012 Series- Contract Revenue Bonds (City of Dallas)			2014 Series- Contract Revenue Bonds (City of Dallas)			Total Enterprise Funds			Annual Payment	Avg Reserve Req after 9/1 Payment	Dallas Monthly Payments (Annual Payment / 12)
	Principal	Interest	Total	Principal	Interest	Total	Principal	Interest	Total			
3/1/2015		2,533,046.88	2,533,046.88		5,140,356.25	5,140,356.25	-	7,673,403.13	7,673,403.13			
9/1/2015	2,835,000.00	2,533,046.88	5,368,046.88	3,040,000.00	5,140,356.25	8,180,356.25	5,875,000.00	7,673,403.13	13,548,403.13			
9/30/2015										21,221,806.26	20,043,686.64	1,768,483.86
3/1/2016		2,476,346.88	2,476,346.88		5,049,156.25	5,049,156.25	-	7,525,503.13	7,525,503.13			
9/1/2016	2,895,000.00	2,476,346.88	5,371,346.88	3,195,000.00	5,049,156.25	8,244,156.25	6,090,000.00	7,525,503.13	13,615,503.13			
9/30/2016										21,141,006.26	20,004,496.66	1,761,750.52
3/1/2017		2,403,971.88	2,403,971.88		4,953,306.25	4,953,306.25	-	7,357,278.13	7,357,278.13			
9/1/2017	2,955,000.00	2,403,971.88	5,358,971.88	3,355,000.00	4,953,306.25	8,308,306.25	6,310,000.00	7,357,278.13	13,667,278.13			
9/30/2017										21,024,556.26	19,966,716.67	1,752,046.36
3/1/2018		2,330,096.88	2,330,096.88		4,852,656.25	4,852,656.25	-	7,182,753.13	7,182,753.13			
9/1/2018	3,015,000.00	2,330,096.88	5,345,096.88	3,520,000.00	4,852,656.25	8,372,656.25	6,535,000.00	7,182,753.13	13,717,753.13			
9/30/2018										20,900,506.26	19,930,801.69	1,741,708.86
3/1/2019		2,254,721.88	2,254,721.88		4,747,056.25	4,747,056.25	-	7,001,778.13	7,001,778.13			
9/1/2019	3,075,000.00	2,254,721.88	5,329,721.88	3,700,000.00	4,747,056.25	8,447,056.25	6,775,000.00	7,001,778.13	13,776,778.13			
9/30/2019										20,778,556.26	19,896,891.50	1,731,546.36
3/1/2020		2,177,846.88	2,177,846.88		4,636,056.25	4,636,056.25	-	6,813,903.13	6,813,903.13			
9/1/2020	3,140,000.00	2,177,846.88	5,317,846.88	3,885,000.00	4,636,056.25	8,521,056.25	7,025,000.00	6,813,903.13	13,838,903.13			
9/30/2020										20,652,806.26	19,865,395.06	1,721,067.19
3/1/2021		2,099,346.88	2,099,346.88		4,519,506.25	4,519,506.25	-	6,618,853.13	6,618,853.13			
9/1/2021	3,200,000.00	2,099,346.88	5,299,346.88	4,075,000.00	4,519,506.25	8,594,506.25	7,275,000.00	6,618,853.13	13,893,853.13			
9/30/2021										20,512,706.26	19,837,251.09	1,709,392.19
3/1/2022		2,019,346.88	2,019,346.88		4,397,256.25	4,397,256.25	-	6,416,603.13	6,416,603.13			
9/1/2022	3,270,000.00	2,019,346.88	5,289,346.88	4,280,000.00	4,397,256.25	8,677,256.25	7,550,000.00	6,416,603.13	13,966,603.13			
9/30/2022										20,383,206.26	19,812,434.95	1,698,600.52
3/1/2023		1,937,596.88	1,937,596.88		4,268,856.25	4,268,856.25	-	6,206,453.13	6,206,453.13			
9/1/2023	3,345,000.00	1,937,596.88	5,282,596.88	4,495,000.00	4,268,856.25	8,763,856.25	7,840,000.00	6,206,453.13	14,046,453.13			
9/30/2023										20,252,906.26	19,791,460.12	1,687,742.19
3/1/2024		1,853,971.88	1,853,971.88		4,134,006.25	4,134,006.25	-	5,987,978.13	5,987,978.13			
9/1/2024	3,515,000.00	1,853,971.88	5,368,971.88	4,720,000.00	4,134,006.25	8,854,006.25	8,235,000.00	5,987,978.13	14,222,978.13			
9/30/2024										20,210,956.26	19,770,485.32	1,684,246.36
3/1/2025		1,801,246.88	1,801,246.88		3,992,406.25	3,992,406.25	-	5,793,653.13	5,793,653.13			
9/1/2025	3,620,000.00	1,801,246.88	5,421,246.88	4,955,000.00	3,992,406.25	8,947,406.25	8,575,000.00	5,793,653.13	14,368,653.13			
9/30/2025										20,162,306.26	19,749,863.16	1,680,192.19
3/1/2026		1,728,846.88	1,728,846.88		3,843,756.25	3,843,756.25	-	5,572,603.13	5,572,603.13			
9/1/2026	3,765,000.00	1,728,846.88	5,493,846.88	5,205,000.00	3,843,756.25	9,048,756.25	8,970,000.00	5,572,603.13	14,542,603.13			
9/30/2026										20,115,206.26	19,729,566.32	1,676,267.19
3/1/2027		1,653,546.88	1,653,546.88		3,739,656.25	3,739,656.25	-	5,393,203.13	5,393,203.13			
9/1/2027	3,920,000.00	1,653,546.88	5,573,546.88	5,465,000.00	3,739,656.25	9,204,656.25	9,385,000.00	5,393,203.13	14,778,203.13			
9/30/2027										20,171,406.26	19,703,575.74	1,680,950.52
3/1/2028		1,594,746.88	1,594,746.88		3,630,356.25	3,630,356.25	-	5,225,103.13	5,225,103.13			
9/1/2028	4,075,000.00	1,594,746.88	5,669,746.88	5,735,000.00	3,630,356.25	9,365,356.25	9,810,000.00	5,225,103.13	15,035,103.13			
9/30/2028										20,260,206.26	19,668,786.33	1,688,350.52
3/1/2029		1,533,621.88	1,533,621.88		3,515,656.25	3,515,656.25	-	5,049,278.13	5,049,278.13			
9/1/2029	4,240,000.00	1,533,621.88	5,773,621.88	6,025,000.00	3,515,656.25	9,540,656.25	10,265,000.00	5,049,278.13	15,314,278.13			
9/30/2029										20,363,556.26	19,622,468.33	1,696,963.02
3/1/2030		1,470,021.88	1,470,021.88		3,365,031.25	3,365,031.25	-	4,835,053.13	4,835,053.13			
9/1/2030	4,415,000.00	1,470,021.88	5,885,021.88	6,325,000.00	3,365,031.25	9,690,031.25	10,740,000.00	4,835,053.13	15,575,053.13			
9/30/2030										20,410,106.26	19,566,208.48	1,700,842.19
3/1/2031		1,403,796.88	1,403,796.88		3,206,906.25	3,206,906.25	-	4,610,703.13	4,610,703.13			
9/1/2031	4,595,000.00	1,403,796.88	5,998,796.88	6,640,000.00	3,208,906.25	9,846,906.25	11,235,000.00	4,610,703.13	15,845,703.13			
9/30/2031										20,456,406.26	19,497,731.73	1,704,700.52
3/1/2032		1,332,000.00	1,332,000.00		3,040,906.25	3,040,906.25	-	4,372,906.25	4,372,906.25			
9/1/2032	4,780,000.00	1,332,000.00	6,112,000.00	6,975,000.00	3,040,906.25	10,015,906.25	11,755,000.00	4,372,906.25	16,127,906.25			
9/30/2032										20,500,812.50	19,414,141.67	1,708,401.04
3/1/2033		1,236,400.00	1,236,400.00		2,866,531.25	2,866,531.25	-	4,102,931.25	4,102,931.25			
9/1/2033	4,970,000.00	1,236,400.00	6,206,400.00	7,320,000.00	2,866,531.25	10,186,531.25	12,290,000.00	4,102,931.25	16,392,931.25			
9/30/2033										20,495,862.50	19,315,803.41	1,707,988.54
3/1/2034		1,137,000.00	1,137,000.00		2,683,531.25	2,683,531.25	-	3,820,531.25	3,820,531.25			
9/1/2034	5,225,000.00	1,137,000.00	6,362,000.00	7,690,000.00	2,683,531.25	10,373,531.25	12,915,000.00	3,820,531.25	16,735,531.25			
9/30/2034										20,556,062.50	19,191,777.50	1,713,005.21
3/1/2035		1,032,500.00	1,032,500.00		2,491,281.25	2,491,281.25	-	3,523,781.25	3,523,781.25			
9/1/2035	5,485,000.00	1,032,500.00	6,517,500.00	8,075,000.00	2,491,281.25	10,566,281.25	13,560,000.00	3,523,781.25	17,083,781.25			
9/30/2035										20,607,562.50	19,034,468.06	1,717,296.88

Dallas Bonds

9/30/2015

Dates	2012 Series- Contract Revenue Bonds (City of Dallas) Principal	Interest	Total	2014 Series- Contract Revenue Bonds (City of Dallas) Principal	Interest	Total	Total Enterprise Funds Principal	Interest	Total	Annual Payment	Avg Reserve Req after 9/1 Payment	Dallas Monthly Payments (Annual Payment / 12)
3/1/2036		922,800.00	922,800.00		2,289,406.25	2,289,406.25	-	3,212,206.25	3,212,206.25			
9/1/2036	5,765,000.00	922,800.00	6,687,800.00	8,475,000.00	2,289,406.25	10,764,406.25	14,240,000.00	3,212,206.25	17,452,206.25			
9/30/2036										20,664,412.50	18,830,725.00	1,722,034.38
3/1/2037		807,500.00	807,500.00		2,077,531.25	2,077,531.25	-	2,885,031.25	2,885,031.25			
9/1/2037	6,055,000.00	807,500.00	6,862,500.00	8,900,000.00	2,077,531.25	10,977,531.25	14,955,000.00	2,885,031.25	17,840,031.25			
9/30/2037										20,725,062.50	18,560,105.36	1,727,088.54
3/1/2038		686,400.00	686,400.00		1,855,031.25	1,855,031.25	-	2,541,431.25	2,541,431.25			
9/1/2038	6,360,000.00	686,400.00	7,046,400.00	9,345,000.00	1,855,031.25	11,200,031.25	15,705,000.00	2,541,431.25	18,246,431.25			
9/30/2038										20,787,862.50	18,188,812.50	1,732,321.88
3/1/2039		559,200.00	559,200.00		1,621,406.25	1,621,406.25	-	2,180,606.25	2,180,606.25			
9/1/2039	6,605,000.00	559,200.00	7,164,200.00	9,810,000.00	1,621,406.25	11,431,406.25	16,415,000.00	2,180,606.25	18,595,606.25			
9/30/2039										20,776,212.50	17,671,332.50	1,731,351.04
3/1/2040		427,100.00	427,100.00		1,376,156.25	1,376,156.25	-	1,803,256.25	1,803,256.25			
9/1/2040	6,855,000.00	427,100.00	7,282,100.00	10,300,000.00	1,376,156.25	11,676,156.25	17,155,000.00	1,803,256.25	18,958,256.25			
9/30/2040										20,761,512.50	16,898,787.50	1,730,126.04
3/1/2041		290,000.00	290,000.00		1,118,656.25	1,118,656.25	-	1,408,656.25	1,408,656.25			
9/1/2041	7,115,000.00	290,000.00	7,405,000.00	10,815,000.00	1,118,656.25	11,933,656.25	17,930,000.00	1,408,656.25	19,338,656.25			
9/30/2041										20,747,312.50	15,615,945.83	1,728,942.71
3/1/2042		147,700.00	147,700.00		848,281.25	848,281.25	-	995,981.25	995,981.25			
9/1/2042	7,385,000.00	147,700.00	7,532,700.00	11,360,000.00	848,281.25	12,208,281.25	18,745,000.00	995,981.25	19,740,981.25			
9/30/2042										20,736,962.50	13,055,437.50	1,728,080.21
3/1/2043	-	-	-		564,281.25	564,281.25	-	564,281.25	564,281.25			
9/1/2043		-	-	11,925,000.00	564,281.25	12,489,281.25	11,925,000.00	564,281.25	12,489,281.25			
9/30/2043										13,053,562.50	13,057,312.50	
3/1/2044	-	-	-		266,156.25	266,156.25	-	266,156.25	266,156.25			
9/1/2044		-	-	12,525,000.00	266,156.25	12,791,156.25	12,525,000.00	266,156.25	12,791,156.25			
9/30/2044										13,057,312.50	-	
3/1/2045	-	-	-			-	-	-	-			
9/1/2045		-	-			-	-	-	-			
9/30/2045										-		
3/1/2046	-	-	-			-	-	-	-			
9/1/2046		-	-			-	-	-	-			
9/30/2046										-		
3/1/2047	-	-	-			-	-	-	-			
9/1/2047		-	-			-	-	-	-			
9/30/2047										-		
3/1/2048	-	-	-			-	-	-	-			
9/1/2048		-	-			-	-	-	-			
9/30/2048										-		
3/1/2049	-	-	-			-	-	-	-			
9/1/2049		-	-			-	-	-	-			
9/30/2049										-		
3/1/2050	-	-	-			-	-	-	-			
9/1/2050		-	-			-	-	-	-			
9/30/2050										-		
3/1/2051	-	-	-			-	-	-	-			
9/1/2051		-	-			-	-	-	-			
9/30/2051										-		
3/1/2052	-	-	-	-	-	-	-	-	-			
9/1/2052		-	-		-	-	-	-	-			
9/30/2052										-		
3/1/2053	-	-	-	-	-	-	-	-	-			
9/1/2053		-	-		-	-	-	-	-			
9/30/2053										-		
Total	126,475,000.00	83,701,443.92	210,176,443.92	202,130,000.00	190,182,275.00	392,312,275.00	328,605,000.00	273,883,718.92	602,488,718.92	602,488,718.92		

Part C #49 B
TRWD

TRWD Bonds
As of 9/30/15

	2006 Series-Water Revenue Refunding and Improvement Bonds (REFUNDED FY2015)			2008A Series-TWDB WIF Program			2008B Series-TWDB WIF Program			2009 Series-Water Revenue Bonds			2010 Series-Water Revenue Bonds			2010A Series-TWDB WIF Deferred		
Dates	Principal	Interest	Total	Principal	Interest	Total	Principal	Interest	Total	Principal	Interest	Total	Principal	Interest	Total	Principal	Interest	Total
3/1/2015	-	4,264,978.13	4,264,978.13	185,000.00	33,019.50	218,019.50	-	-	-	-	1,346,125.00	1,346,125.00	-	2,076,715.63	2,076,715.63	-	-	-
9/1/2015			-		31,555.23	31,555.23		-	-		1,346,125.00	1,346,125.00		2,076,715.63	2,076,715.63		-	-
9/30/2015																		
3/1/2016				190,000.00	31,555.23	221,555.23	-	-	-	-	1,346,125.00	1,346,125.00	-	2,076,715.63	2,076,715.63	-	-	-
9/1/2016					29,908.88	29,908.88		-	-		1,346,125.00	1,346,125.00		2,076,715.63	2,076,715.63		-	-
9/30/2016																		
3/1/2017				195,000.00	29,908.88	224,908.88	-	-	-	-	1,346,125.00	1,346,125.00	-	2,076,715.63	2,076,715.63	-	-	-
9/1/2017					28,072.95	28,072.95		-	-		1,346,125.00	1,346,125.00		2,076,715.63	2,076,715.63		-	-
9/30/2017																		
3/1/2018				195,000.00	28,072.95	223,072.95	605,000.00	52,928.03	657,928.03	3,360,000.00	1,346,125.00	4,706,125.00	2,120,000.00	2,076,715.63	4,196,715.63	1,305,000.00	62,532.75	1,367,532.75
9/1/2018					26,110.28	26,110.28		46,838.70	46,838.70		1,262,125.00	1,262,125.00		2,029,015.63	2,029,015.63		180,087.98	180,087.98
9/30/2018																		
3/1/2019				200,000.00	26,110.28	226,110.28	620,000.00	46,838.70	666,838.70	3,530,000.00	1,262,125.00	4,792,125.00	2,230,000.00	2,029,015.63	4,259,015.63	1,160,000.00	180,087.98	1,340,087.98
9/1/2019					23,977.28	23,977.28		40,226.40	40,226.40		1,173,875.00	1,173,875.00		1,978,840.63	1,978,840.63		172,426.18	172,426.18
9/30/2019																		
3/1/2020				205,000.00	23,977.28	228,977.28	630,000.00	40,226.40	670,226.40	3,710,000.00	1,173,875.00	4,883,875.00	2,345,000.00	1,978,840.63	4,323,840.63	1,200,000.00	172,426.18	1,372,426.18
9/1/2020					21,551.10	21,551.10		32,770.35	32,770.35		1,081,125.00	1,081,125.00		1,920,215.63	1,920,215.63		162,880.18	162,880.18
9/30/2020																		
3/1/2021				210,000.00	21,551.10	231,551.10	645,000.00	32,770.35	677,770.35	3,900,000.00	1,081,125.00	4,981,125.00	2,465,000.00	1,920,215.63	4,385,215.63	1,235,000.00	162,880.18	1,397,880.18
9/1/2021					18,937.65	18,937.65		24,743.33	24,743.33		983,625.00	983,625.00		1,858,590.63	1,858,590.63		151,647.85	151,647.85
9/30/2021																		
3/1/2022				215,000.00	18,937.65	233,937.65	665,000.00	24,743.33	689,743.33	4,100,000.00	983,625.00	5,083,625.00	2,590,000.00	1,858,590.63	4,448,590.63	1,270,000.00	151,647.85	1,421,647.85
9/1/2022					16,171.68	16,171.68		16,188.10	16,188.10		881,125.00	881,125.00		1,793,840.63	1,793,840.63		139,049.45	139,049.45
9/30/2022																		
3/1/2023				220,000.00	16,171.68	236,171.68	680,000.00	16,188.10	696,188.10	4,315,000.00	881,125.00	5,196,125.00	2,720,000.00	1,793,840.63	4,513,840.63	1,310,000.00	139,049.45	1,449,049.45
9/1/2023					13,257.78	13,257.78		7,181.50	7,181.50		773,250.00	773,250.00		1,725,840.63	1,725,840.63		125,314.10	125,314.10
9/30/2023																		
3/1/2024				225,000.00	13,257.78	238,257.78	530,000.00	7,181.50	537,181.50	4,535,000.00	773,250.00	5,308,250.00	2,860,000.00	1,725,840.63	4,585,840.63	1,350,000.00	125,314.10	1,475,314.10
9/1/2024					10,209.03	10,209.03			-		659,875.00	659,875.00		1,668,640.63	1,668,640.63		111,199.85	111,199.85
9/30/2024																		
3/1/2025				235,000.00	10,209.03	245,209.03				4,765,000.00	659,875.00	5,424,875.00	3,010,000.00	1,668,640.63	4,678,640.63	1,390,000.00	111,199.85	1,501,199.85
9/1/2025					6,967.20	6,967.20					540,750.00	540,750.00		1,608,440.63	1,608,440.63		95,326.05	95,326.05
9/30/2025																		
3/1/2026				240,000.00	6,967.20	246,967.20				5,010,000.00	540,750.00	5,550,750.00	3,160,000.00	1,608,440.63	4,768,440.63	1,435,000.00	95,326.05	1,530,326.05
9/1/2026					3,610.80	3,610.80					415,500.00	415,500.00		1,529,440.63	1,529,440.63		78,314.13	78,314.13
9/30/2026																		
3/1/2027				255,000.00	3,610.80	258,610.80				5,265,000.00	415,500.00	5,680,500.00	3,325,000.00	1,529,440.63	4,854,440.63	1,475,000.00	78,314.13	1,553,314.13
9/1/2027					-	-		-	-		283,875.00	283,875.00		1,446,315.63	1,446,315.63		60,304.38	60,304.38
9/30/2027																		
3/1/2028		-	-	-	-	-	-	-	-	5,535,000.00	283,875.00	5,818,875.00	3,495,000.00	1,446,315.63	4,941,315.63	1,520,000.00	60,304.38	1,580,304.38
9/1/2028			-	-		-	-	-	-		145,500.00	145,500.00		1,358,940.63	1,358,940.63		41,197.98	41,197.98
9/30/2028																		
3/1/2029		-	-	-	-	-	-	-	-	5,820,000.00	145,500.00	5,965,500.00	3,675,000.00	1,358,940.63	5,033,940.63	1,570,000.00	41,197.98	1,611,197.98
9/1/2029														1,267,065.63	1,267,065.63		20,890.03	20,890.03
9/30/2029																		
3/1/2030		-	-	-	-	-	-	-	-	-	-	-	3,865,000.00	1,267,065.63	5,132,065.63	1,615,000.00	20,890.03	1,635,890.03
9/1/2030			-	-		-	-	-	-		-	-		1,170,440.63	1,170,440.63		-	-
9/30/2030																		
3/1/2031		-	-	-	-	-	-	-	-	-	-	-	4,060,000.00	1,170,440.63	5,230,440.63	-	-	-
9/1/2031			-	-		-	-	-	-		-	-		1,084,165.63	1,084,165.63		-	-
9/30/2031																		
3/1/2032		-	-	-	-	-	-	-	-	-	-	-	4,270,000.00	1,084,165.63	5,354,165.63	-	-	-
9/1/2032			-	-		-	-	-	-		-	-		977,415.63	977,415.63		-	-
9/30/2032																		
3/1/2033		-	-	-	-	-	-	-	-	-	-	-	4,490,000.00	977,415.63	5,467,415.63	-	-	-
9/1/2033			-	-		-	-	-	-		-	-		879,196.88	879,196.88		-	-
9/30/2033																		

Dates	2006 Series-Water Revenue Refunding and Improvement Bonds (REFUNDED FY2015)			2008A Series-TWDB WIF Program			2008B Series-TWDB WIF Program			2009 Series-Water Revenue Bonds			2010 Series-Water Revenue Bonds			2010A Series-TWDB WIF Deferred		
	Principal	Interest	Total	Principal	Interest	Total	Principal	Interest	Total	Principal	Interest	Total	Principal	Interest	Total	Principal	Interest	Total
3/1/2034				-	-	-	-	-	-	-	-	-	4,720,000.00	879,196.88	5,599,196.88	-	-	-
9/1/2034					-	-		-	-		-	-		772,996.88	772,996.88		-	-
9/30/2034																		
3/1/2035				-	-	-	-	-	-	-	-	-	4,960,000.00	772,996.88	5,732,996.88	-	-	-
9/1/2035					-	-		-	-		-	-		661,396.88	661,396.88		-	-
9/30/2035																		
3/1/2036				-	-	-	-	-	-	-	-	-	5,215,000.00	661,396.88	5,876,396.88	-	-	-
9/1/2036					-	-		-	-		-	-		544,059.38	544,059.38		-	-
9/30/2036																		
3/1/2037				-	-	-	-	-	-	-	-	-	5,480,000.00	544,059.38	6,024,059.38	-	-	-
9/1/2037					-	-		-	-		-	-		420,759.38	420,759.38		-	-
9/30/2037																		
3/1/2038				-	-	-	-	-	-	-	-	-	5,765,000.00	420,759.38	6,185,759.38	-	-	-
9/1/2038					-	-		-	-		-	-		287,443.75	287,443.75		-	-
9/30/2038																		
3/1/2039				-	-	-	-	-	-	-	-	-	6,060,000.00	287,443.75	6,347,443.75	-	-	-
9/1/2039					-	-		-	-		-	-		147,306.25	147,306.25		-	-
9/30/2039																		
3/1/2040				-	-	-	-	-	-	-	-	-	6,370,000.00	147,306.25	6,517,306.25	-	-	-
9/1/2040					-	-		-	-		-	-		-	-		-	-
9/30/2040																		
3/1/2041				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9/1/2041					-	-		-	-		-	-		-	-		-	-
9/30/2041																		
3/1/2042				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9/1/2042					-	-		-	-		-	-		-	-		-	-
9/30/2042																		
3/1/2043				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9/1/2043					-	-		-	-		-	-		-	-		-	-
9/30/2043																		
3/1/2044				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9/1/2044					-	-		-	-		-	-		-	-		-	-
9/30/2044																		
3/1/2045				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9/1/2045					-	-		-	-		-	-		-	-		-	-
9/30/2045																		
3/1/2046				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9/1/2046					-	-		-	-		-	-		-	-		-	-
9/30/2046																		
3/1/2047				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9/1/2047					-	-		-	-		-	-		-	-		-	-
9/30/2047																		
3/1/2048				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9/1/2048					-	-		-	-		-	-		-	-		-	-
9/30/2048																		
3/1/2049	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9/1/2049		-	-		-	-		-	-		-	-		-	-		-	-
9/30/2049																		
3/1/2050	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9/1/2050		-	-		-	-		-	-		-	-		-	-		-	-
9/30/2050																		
3/1/2051	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9/1/2051		-	-		-	-		-	-		-	-		-	-		-	-
9/30/2051																		
3/1/2052	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9/1/2052		-	-		-	-		-	-		-	-		-	-		-	-
9/30/2052																		
3/1/2053	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9/1/2053		-	-		-	-		-	-		-	-		-	-		-	-
9/30/2053																		
Total	-	4,264,978.13	4,264,978.13	2,770,000.00	493,679.22	3,263,679.22	4,375,000.00	388,824.79	4,763,824.79	53,845,000.00	25,824,125.00	79,669,125.00	89,250,000.00	68,797,747.11	158,047,747.11	17,835,000.00	2,739,809.07	20,574,809.07

TRWD Bonds
As of 9/30/15

Dates	2010B Series-TWDB WIF Construction			2012 Series- Refunding and Water Revenue			2012A Series-Water Revenue Refunding Bonds			2014 Series-Water Revenue Bonds			2015 Series-Water Revenue Bonds			Total Enterprise Funds			
	Principal	Interest	Total	Principal	Interest	Total	Principal	Interest	Total	Principal	Interest	Total	Principal	Interest	Total	Principal	Interest	Total	Annual Payment
3/1/2015	3,500,000.00	627,168.88	4,127,168.88	5,660,000.00	3,569,875.00	9,229,875.00	19,445,000.00	1,925,725.00	21,370,725.00	2,490,000.00	7,950,675.00	10,440,675.00			-	31,280,000.00	21,794,282.14	53,074,282.14	
9/1/2015		625,855.38	625,855.38		3,428,375.00	3,428,375.00		1,439,600.00	1,439,600.00		7,900,875.00	7,900,875.00		3,845,516.94	3,845,516.94	-	20,694,618.18	20,694,618.18	
9/30/2015																			73,768,900.32
3/1/2016	3,605,000.00	625,855.38	4,230,855.38	5,950,000.00	3,428,375.00	9,378,375.00	20,440,000.00	1,439,600.00	21,879,600.00		7,900,875.00	7,900,875.00	760,000.00	3,888,725.00	4,648,725.00	30,945,000.00	20,737,826.24	51,682,826.24	
9/1/2016		617,113.25	617,113.25		3,279,625.00	3,279,625.00		928,600.00	928,600.00		7,900,875.00	7,900,875.00		3,881,125.00	3,881,125.00	-	20,060,087.76	20,060,087.76	
9/30/2016																			71,742,914.00
3/1/2017	3,715,000.00	617,113.25	4,332,113.25	6,100,000.00	3,279,625.00	9,379,625.00	20,965,000.00	928,600.00	21,893,600.00		7,900,875.00	7,900,875.00	775,000.00	3,881,125.00	4,656,125.00	31,750,000.00	20,060,087.76	51,810,087.76	
9/1/2017		602,531.88	602,531.88		3,127,125.00	3,127,125.00		404,475.00	404,475.00		7,900,875.00	7,900,875.00		3,873,375.00	3,873,375.00	-	19,359,295.46	19,359,295.46	
9/30/2017																			71,169,383.22
3/1/2018	3,830,000.00	602,531.88	4,432,531.88	735,000.00	3,127,125.00	3,862,125.00	3,255,000.00	404,475.00	3,659,475.00		7,900,875.00	7,900,875.00	9,535,000.00	3,873,375.00	13,408,375.00	24,940,000.00	19,474,756.24	44,414,756.24	
9/1/2018		583,477.63	583,477.63		3,119,775.00	3,119,775.00		323,100.00	323,100.00		7,900,875.00	7,900,875.00		3,635,000.00	3,635,000.00	-	19,106,405.22	19,106,405.22	
9/30/2018																			63,521,161.46
3/1/2019	3,945,000.00	583,477.63	4,528,477.63	750,000.00	3,119,775.00	3,869,775.00	3,410,000.00	323,100.00	3,733,100.00	895,000.00	7,900,875.00	8,795,875.00	10,030,000.00	3,635,000.00	13,665,000.00	26,770,000.00	19,106,405.22	45,876,405.22	
9/1/2019		560,103.50	560,103.50		3,108,525.00	3,108,525.00		249,100.00	249,100.00		7,878,500.00	7,878,500.00		3,384,250.00	3,384,250.00	-	18,569,823.99	18,569,823.99	
9/30/2019																			64,446,229.21
3/1/2020	4,065,000.00	560,103.50	4,625,103.50	770,000.00	3,108,525.00	3,878,525.00	3,555,000.00	249,100.00	3,804,100.00	1,405,000.00	7,878,500.00	9,283,500.00	10,540,000.00	3,384,250.00	13,924,250.00	28,425,000.00	18,569,823.99	46,994,823.99	
9/1/2020		530,652.58	530,652.58		3,100,825.00	3,100,825.00		178,000.00	178,000.00		7,843,375.00	7,843,375.00		3,120,750.00	3,120,750.00	-	17,992,144.84	17,992,144.84	
9/30/2020																			64,986,968.83
3/1/2021	4,190,000.00	530,652.58	4,720,652.58	790,000.00	3,100,825.00	3,890,825.00	3,720,000.00	178,000.00	3,898,000.00	805,000.00	7,843,375.00	8,648,375.00	11,085,000.00	3,120,750.00	14,205,750.00	29,045,000.00	17,992,144.84	47,037,144.84	
9/1/2021		495,372.78	495,372.78		3,088,975.00	3,088,975.00		85,000.00	85,000.00		7,823,250.00	7,823,250.00		2,843,625.00	2,843,625.00	-	17,373,767.24	17,373,767.24	
9/30/2021																			64,410,912.08
3/1/2022	4,315,000.00	495,372.78	4,810,372.78	815,000.00	3,088,975.00	3,903,975.00	3,900,000.00	85,000.00	3,985,000.00	1,125,000.00	7,823,250.00	8,948,250.00	11,650,000.00	2,843,625.00	14,493,625.00	30,645,000.00	17,373,767.24	48,018,767.24	
9/1/2022		455,804.23	455,804.23		3,076,750.00	3,076,750.00			-		7,800,750.00	7,800,750.00		2,552,375.00	2,552,375.00	-	16,732,054.09	16,732,054.09	
9/30/2022																			64,750,821.33
3/1/2023	4,450,000.00	455,804.23	4,905,804.23	-	3,076,750.00	3,076,750.00					7,800,750.00	7,800,750.00	15,985,000.00	2,552,375.00	18,537,375.00	29,680,000.00	16,732,054.09	46,412,054.09	
9/1/2023		411,771.48	411,771.48		3,076,750.00	3,076,750.00					7,800,750.00	7,800,750.00		2,152,750.00	2,152,750.00	-	16,086,865.49	16,086,865.49	
9/30/2023																			62,498,919.58
3/1/2024	4,585,000.00	411,771.48	4,996,771.48	-	3,076,750.00	3,076,750.00					7,800,750.00	7,800,750.00	14,400,000.00	2,152,750.00	16,552,750.00	28,485,000.00	16,086,865.49	44,571,865.49	
9/1/2024		363,812.38	363,812.38		3,076,750.00	3,076,750.00					7,800,750.00	7,800,750.00		1,792,750.00	1,792,750.00	-	15,483,986.89	15,483,986.89	
9/30/2024																			60,055,852.38
3/1/2025	4,725,000.00	363,812.38	5,088,812.38	-	3,076,750.00	3,076,750.00					7,800,750.00	7,800,750.00	12,945,000.00	1,792,750.00	14,737,750.00	27,070,000.00	15,483,986.89	42,553,986.89	
9/1/2025		312,026.38	312,026.38		3,076,750.00	3,076,750.00					7,800,750.00	7,800,750.00		1,469,125.00	1,469,125.00	-	14,910,135.26	14,910,135.26	
9/30/2025																			57,464,122.15
3/1/2026	4,865,000.00	312,026.38	5,177,026.38	-	3,076,750.00	3,076,750.00					7,800,750.00	7,800,750.00	13,610,000.00	1,469,125.00	15,079,125.00	28,320,000.00	14,910,135.26	43,230,135.26	
9/1/2026		256,541.05	256,541.05		3,076,750.00	3,076,750.00					7,800,750.00	7,800,750.00		1,128,875.00	1,128,875.00	-	14,289,781.61	14,289,781.61	
9/30/2026																			57,519,916.87
3/1/2027	5,015,000.00	256,541.05	5,271,541.05	-	3,076,750.00	3,076,750.00					7,800,750.00	7,800,750.00	14,305,000.00	1,128,875.00	15,433,875.00	29,640,000.00	14,289,781.61	43,929,781.61	
9/1/2027		197,288.83	197,288.83		3,076,750.00	3,076,750.00					7,800,750.00	7,800,750.00		771,250.00	771,250.00	-	13,636,533.84	13,636,533.84	
9/30/2027																			57,566,315.45
3/1/2028	5,170,000.00	197,288.83	5,367,288.83	-	3,076,750.00	3,076,750.00					7,800,750.00	7,800,750.00	15,040,000.00	771,250.00	15,811,250.00	30,760,000.00	13,636,533.84	44,396,533.84	
9/1/2028		134,292.38	134,292.38		3,076,750.00	3,076,750.00					7,800,750.00	7,800,750.00		395,250.00	395,250.00	-	12,952,680.99	12,952,680.99	
9/30/2028																			57,349,214.83
3/1/2029	5,325,000.00	134,292.38	5,459,292.38	-	3,076,750.00	3,076,750.00					7,800,750.00	7,800,750.00	15,810,000.00	395,250.00	16,205,250.00	32,200,000.00	12,952,680.99	45,152,680.99	
9/1/2029		68,076.00	68,076.00		3,076,750.00	3,076,750.00					7,800,750.00	7,800,750.00			-	-	12,233,531.66	12,233,531.66	
9/30/2029																			57,386,212.65
3/1/2030	5,490,000.00	68,076.00	5,558,076.00	-	3,076,750.00	3,076,750.00				18,735,000.00	7,800,750.00	26,535,750.00			-	29,705,000.00	12,233,531.66	41,938,531.66	
9/1/2030		-	-		3,076,750.00	3,076,750.00					7,332,375.00	7,332,375.00			-	-	11,579,565.63	11,579,565.63	
9/30/2030																			53,518,097.29
3/1/2031	-	-	-	6,450,000.00	3,076,750.00	9,526,750.00				20,355,000.00	7,332,375.00	27,687,375.00			-	30,865,000.00	11,579,565.63	42,444,565.63	
9/1/2031		-	-		2,915,500.00	2,915,500.00					6,823,500.00	6,823,500.00			-	-	10,823,165.63	10,823,165.63	
9/30/2031																			53,267,731.26
3/1/2032	-	-	-	6,750,000.00	2,915,500.00	9,685,500.00				21,145,000.00	6,823,500.00	27,968,500.00			-	32,165,000.00	10,823,165.63	42,988,165.63	
9/1/2032		-	-		2,755,500.00	2,755,500.00					6,294,875.00	6,294,875.00			-	-	10,027,790.63	10,027,790.63	
9/30/2032																			53,015,956.26
3/1/2033	-	-	-	7,065,000.00	2,755,500.00	9,820,500.00				21,980,000.00	8,294,875.00	28,274,875.00			-	33,535,000.00	10,027,790.63	43,562,790.63	
9/1/2033		-	-		2,578,875.00	2,578,875.00					5,745,375.00	5,745,375.00			-	-	9,203,446.88	9,203,446.88	
9/30/2033																			52,766,237.51

	2010B Series-TWDB WIF Construction			2012 Series- Refunding and Water Revenue			2012A Series-Water Revenue Refunding Bonds			2014 Series-Water Revenue Bonds			2015 Series-Water Revenue Bonds			Total Enterprise Funds			
Dates	Principal	Interest	Total	Principal	Interest	Total	Principal	Interest	Total	Principal	Interest	Total	Principal	Interest	Total	Principal	Interest	Total	Annual Payment
3/1/2034	-	-	-	7,375,000.00	2,578,875.00	9,953,875.00				22,880,000.00	5,745,375.00	28,625,375.00			-	34,975,000.00	9,203,446.88	44,178,446.88	
9/1/2034		-	-		2,394,500.00	2,394,500.00					5,173,375.00	5,173,375.00			-	-	8,340,871.88	8,340,871.88	
9/30/2034																			52,519,318.76
3/1/2035	-	-	-	7,725,000.00	2,394,500.00	10,119,500.00				9,495,000.00	5,173,375.00	14,668,375.00			-	22,180,000.00	8,340,871.88	30,520,871.88	
9/1/2035		-	-		2,201,375.00	2,201,375.00					4,936,000.00	4,936,000.00			-	-	7,798,771.88	7,798,771.88	
9/30/2035																			38,319,643.76
3/1/2036	-	-	-	8,070,000.00	2,201,375.00	10,271,375.00				9,980,000.00	4,936,000.00	14,916,000.00			-	23,265,000.00	7,798,771.88	31,063,771.88	
9/1/2036		-	-		1,999,625.00	1,999,625.00					4,686,500.00	4,686,500.00			-	-	7,230,184.38	7,230,184.38	
9/30/2036																			38,293,956.26
3/1/2037	-	-	-	8,445,000.00	1,999,625.00	10,444,625.00				10,490,000.00	4,686,500.00	15,176,500.00			-	24,415,000.00	7,230,184.38	31,645,184.38	
9/1/2037		-	-		1,788,500.00	1,788,500.00					4,424,250.00	4,424,250.00			-	-	6,633,509.38	6,633,509.38	
9/30/2037																			38,278,693.76
3/1/2038	-	-	-	-	1,788,500.00	1,788,500.00				11,030,000.00	4,424,250.00	15,454,250.00			-	16,795,000.00	6,633,509.38	23,428,509.38	
9/1/2038		-	-		1,788,500.00	1,788,500.00					4,148,500.00	4,148,500.00			-	-	6,224,443.75	6,224,443.75	
9/30/2038																			29,652,953.13
3/1/2039	-	-	-	-	1,788,500.00	1,788,500.00				11,595,000.00	4,148,500.00	15,743,500.00			-	17,655,000.00	6,224,443.75	23,879,443.75	
9/1/2039		-	-		1,788,500.00	1,788,500.00					3,858,625.00	3,858,625.00			-	-	5,794,431.25	5,794,431.25	
9/30/2039																			29,673,875.00
3/1/2040	-	-	-	-	1,788,500.00	1,788,500.00				12,190,000.00	3,858,625.00	16,048,625.00			-	18,560,000.00	5,794,431.25	24,354,431.25	
9/1/2040		-	-	-	1,788,500.00	1,788,500.00					3,553,875.00	3,553,875.00			-	-	5,342,375.00	5,342,375.00	
9/30/2040																			29,696,806.25
3/1/2041	-	-	-	4,460,000.00	1,788,500.00	6,248,500.00				12,815,000.00	3,553,875.00	16,368,875.00			-	17,275,000.00	5,342,375.00	22,617,375.00	
9/1/2041		-	-		1,677,000.00	1,677,000.00					3,233,500.00	3,233,500.00			-	-	4,910,500.00	4,910,500.00	
9/30/2041																			27,527,875.00
3/1/2042	-	-	-	4,690,000.00	1,677,000.00	6,367,000.00				13,470,000.00	3,233,500.00	16,703,500.00			-	18,160,000.00	4,910,500.00	23,070,500.00	
9/1/2042		-	-		1,559,750.00	1,559,750.00					2,896,750.00	2,896,750.00			-	-	4,456,500.00	4,456,500.00	
9/30/2042																			27,527,000.00
3/1/2043	-	-	-	4,930,000.00	1,559,750.00	6,489,750.00				14,160,000.00	2,896,750.00	17,056,750.00			-	19,090,000.00	4,456,500.00	23,546,500.00	
9/1/2043		-	-		1,436,500.00	1,436,500.00					2,542,750.00	2,542,750.00			-	-	3,979,250.00	3,979,250.00	
9/30/2043																			27,525,750.00
3/1/2044	-	-	-	5,185,000.00	1,436,500.00	6,621,500.00				14,890,000.00	2,542,750.00	17,432,750.00			-	20,075,000.00	3,979,250.00	24,054,250.00	
9/1/2044		-	-		1,306,875.00	1,306,875.00					2,170,500.00	2,170,500.00			-	-	3,477,375.00	3,477,375.00	
9/30/2044																			27,531,625.00
3/1/2045	-	-	-	5,450,000.00	1,306,875.00	6,756,875.00				15,650,000.00	2,170,500.00	17,820,500.00			-	21,100,000.00	3,477,375.00	24,577,375.00	
9/1/2045		-	-		1,170,625.00	1,170,625.00					1,779,250.00	1,779,250.00			-	-	2,949,875.00	2,949,875.00	
9/30/2045																			27,527,250.00
3/1/2046	-	-	-	5,730,000.00	1,170,625.00	6,900,625.00				16,455,000.00	1,779,250.00	18,234,250.00			-	22,185,000.00	2,949,875.00	25,134,875.00	
9/1/2046		-	-		1,027,375.00	1,027,375.00					1,367,875.00	1,367,875.00			-	-	2,395,250.00	2,395,250.00	
9/30/2046																			27,530,125.00
3/1/2047	-	-	-	6,025,000.00	1,027,375.00	7,052,375.00				17,330,000.00	1,367,875.00	18,697,875.00			-	23,355,000.00	2,395,250.00	25,750,250.00	
9/1/2047		-	-		876,750.00	876,750.00					934,625.00	934,625.00			-	-	1,811,375.00	1,811,375.00	
9/30/2047																			27,561,625.00
3/1/2048	-	-	-	6,330,000.00	876,750.00	7,206,750.00				18,220,000.00	934,625.00	19,154,625.00			-	24,550,000.00	1,811,375.00	26,361,375.00	
9/1/2048		-	-		718,500.00	718,500.00					479,125.00	479,125.00			-	-	1,197,625.00	1,197,625.00	
9/30/2048																			27,559,000.00
3/1/2049	-	-	-	6,655,000.00	718,500.00	7,373,500.00				19,165,000.00	479,125.00	19,644,125.00			-	25,820,000.00	1,197,625.00	27,017,625.00	
9/1/2049		-	-		552,125.00	552,125.00						-			-	-	552,125.00	552,125.00	
9/30/2049																			27,569,750.00
3/1/2050	-	-	-	6,995,000.00	552,125.00	7,547,125.00										6,995,000.00	552,125.00	7,547,125.00	
9/1/2050		-	-		377,250.00	377,250.00										-	377,250.00	377,250.00	
9/30/2050																			7,924,375.00
3/1/2051	-	-	-	7,355,000.00	377,250.00	7,732,250.00										7,355,000.00	377,250.00	7,732,250.00	
9/1/2051		-	-		193,375.00	193,375.00										-	193,375.00	193,375.00	
9/30/2051																			7,925,625.00
3/1/2052	-	-	-	7,735,000.00	193,375.00	7,928,375.00										7,735,000.00	193,375.00	7,928,375.00	
9/1/2052		-	-		-	-										-	-	-	
9/30/2052																			7,928,375.00
3/1/2053	-	-	-	-	-	-										-	-	-	
9/1/2053		-	-		-	-										-	-	-	
9/30/2053																			-
Total	70,790,000.00	13,056,608.34	83,846,608.34	144,990,000.00	169,248,825.00	314,238,825.00	78,690,000.00	9,141,475.00	87,831,475.00	318,750,000.00	387,823,175.00	706,573,175.00	156,470,000.00	69,735,241.94	226,205,241.94	937,765,000.00	751,514,488.60	1,689,279,488.60	1,689,279,488.60

Part D: Project information

54. Project Description

Tarrant Regional Water District (TRWD) and the City of Dallas (DWU) have partnered to finance, plan, design construct and operate the Integrated Pipeline (IPL) Project. The IPL Project is an integrated water delivery transmission system connecting Lake Palestine to Lake Benbrook with additional connections to Cedar Creek and Richland-Chambers Reservoirs and interconnections to TRWD's existing pipelines that creates flexibility in delivery as well as quick response to fluctuating customer water demands. The IPL Project consists of 150 miles of pipeline, three new lake pump stations, and three new booster pump stations delivering a required capacity of 350 million gallons per day (MGD) of raw water to North Central Texas. TRWD and DWU currently serve over 4.1 million residents and the IPL will allow these agencies to continue supporting regional community and economic growth. The funding in this bond issue would pay for multiple sections of the pipeline, a lake pump station, a booster pump station, high voltage power, communications transmission infrastructure, project related soft costs, issuance costs and a reserve fund.

The IPL Project is planned and designed for a five phase sequence of construction. Phases 1 and 2 are scheduled to be constructed and operational by the first quarter of 2020. Phases 3, 4 and 5 are TRWD and Dallas demand and/or future source availability dependent and, therefore, may not be initiated in the numerical sequential order shown. If approved, the Texas Water Development Board Financial Assistance funds will be applied to projects in Phases 1 and 2. Following are the primary IPL system components and their associated construction sequences --

1. **Phase 1 -- RCPL Interconnect to RCCCPL Interconnect**
    a. **Pipeline Section 15-1 --** 15.49-miles x 108-inch pipe
    b. **Joint Booster Pump Station 3 (JB3) Reservoirs --** 2 each, 40-million gallon reservoirs
    c. **Pipeline Sections 12 and 13 and Midlothian Balancing Reservoir --** 13.62-miles x 108-inch pipe and 3 each 133.3-million gallon reservoirs
    d. **Joint Booster Pump Station 4 (JB4) Interconnect to Section 12 --** .25-miles (1,332-feet) x 108-inch pipe
    e. **Richland Chambers Cedar Creek Section 12 (RCCC) Interconnect --** 350-MGD control facility splits flow between TRWD and DWU
    f. **Section 12 Dallas Water Utilities Outlet Connection** -- IPL to DWU interconnection
    g. **IPL Microwave Communications --** Control communications network
    h. **SCADA Installation and Application Engineering --** Expansion of existing SCADA system to include IPL phases 1 and 2
    i. **Joint Booster Pump Station 3 (JB3) --** 350-MGD low capacity booster pump station
    j. **Joint Booster Pump Station (JB3) Electrical Substation --** 138-kV, 46-MVA electric substation
    k. **Pipeline Section 15-2 --** 13.22-miles x 108-inch pipe
    l. **Pipeline Section 14 --** 15.1-miles x 108-inch pipe
    m. **Owner Furnished Equipment re: Richland Chambers Interconnect Valves --**12-each 42-inch butterfly valves
    n. **Owner Furnished Equipment re:** Mainline and Reservoir Gate Valves -- 5-each -- 108-inch isolation gate valves
    o. **Owner Furnished Equipment re: Mainline and Reservoir Butterfly Valves --** 4-each 60-inch and 6-each 108-inch mainline isolation butterfly valves
    p. **Owner Furnished Equipment re: JB3 Isolation Butterfly Valves --** 7-each 54-inch and 3-each 108-inch JB3 isolation butterfly valves

q. **Owner Furnished Equipment re: RCCC Interconnect Control Valves --** 2-each 60-inch multi-orifice valves
r. **Owner Furnished Equipment re: JB3 Pumps, Motors, Drives --** 5-each pump, motor, and drive assemblies

2. Phase 2 – Joint Cedar Creek Lake Pump Station and Kennedale Balancing Reservoir Connections

a. **Pipeline Sections 10 and 11 --** 12.31-miles x 84-inch pipe
b. **Joint Booster Pump Station 4 (JB4) By Pass to Section 11** -- .38-miles (1,990-feet) x 84-inch pipe
c. **Section 10 Pressure Reducing Station --** 200-MGD pressure control interconnect station
d. **Pipeline Section 17 Trinity River Tunnel --** .682- miles (3,600-feet) x 108-inch finished tunnel
e. **Pipeline Sections 17 and 18 --** 9.04-miles x 108-inch pipe
f. **Joint Booster Pump station 2 (JB2) Bypass --** 1.04-miles x 108-inch pipe
g. Joint Cedar Creek Lake Pump Station (JCC1) Intake and Wetwell **--** 277-MGD lake intake and wetwell
h. **Joint Cedar Creek Lake Pump Station (JCC1) --** 277-MGD lake pump station
i. **Joint Cedar Creek Lake Pump Station (JCC1) Electrical Substation --** 138-kV, 27-MVA electric substation
j. **Owner Furnished Equipment re: JCC1 Ball Valves --** 5-each 36-inch and 18-inch pump control valves
k. **Owner Furnished Equipment re: JCC1 and Mainline Isolation Gate Valves --** 2-each 108-inch isolation gate valves
l. **Owner Furnished Equipment re: JCC1 Pumps, Motors, Drives --** 7-each pump, motor, and drive assemblies

Phase 3 -5 Construction timing to be determined at a later date based on demands

3. Phase 3 -- Lake Palestine Connection

a. **Pipeline Section 19-1 --** 20.73-miles x 84-inch pipe
b. **Pipeline Section 19-2 --** 20.94-miles x 84-inch pipe
c. **Lake Palestine Pump Station (LP1) Intake and Wetwell --** 150-MGD lake intake and wetwell
d. **Lake Palestine Pump Station (LP1) --** 150-MGD lake pump station
e. **Lake Palestine Pump Station (LP1) Electrical Substation --** 138-kV, 23-MVA electric substation
f. **Joint Booster Pump Station 2 (JB2) Reservoirs –** 2-each, 40-million gallon reservoirs
g. **Joint Booster Pump Station 2 (JB2) --** 350-MGD high capacity booster pump station
h. **Joint Booster Pump Station (JB2) Electrical Substation --** 138-kV, 41-MVA electric substation

4. Phase 4 -- Richland Chambers Reservoir Connection

a. **Pipeline Section 16 --** 12.31-miles x 96-inch pipe
b. **Joint Richland Chambers Lake Pump Station (JRC1) Intake and Wetwell --** 250-MGD lake intake and wetwell
c. **Joint Richland Chambers Lake Pump Station (JRC1)** -- 250-MGD lake pump station
d. **Joint Richland Chambers Lake Pump Station (JRC1) Electrical Substation --** 138-kV, 20-MVA electric substation

5. Phase 5 -- Lake Benbrook Connection

a. **Pipeline Section 9 --** 10.71-miles x 84-inch pipe
b. **Pipeline Section 9 Deep Tunnel --** 5.0-miles x 120-inch finished tunnel

c. **Joint Booster Pump Station 4 (JB4) --** 200-MGD high capacity booster pump station
d. **Joint Booster Pump Station 4 (JB4) Electrical Substation --** 138-kV, 20-MVA electric substation

6. Alternatives Considered –

Several component alternatives were considered and evaluated during the course of IPL project planning, development, and design that focused on operational efficiency, service life, reliability/redundancy, sustainability, and life cycle cost. Several system configuration/component alternative considerations are --

a. **Integrated Pipeline –** TRWD and Dallas joint pipeline with dual service capability versus TRWD and Dallas independent pipelines re: joint or shared capital and life cycle cost savings
b. **Pipeline right-of-way (ROW) –** build the IPL in existing TRWD ROW versus new ROW re: system security and reliability.
c. **Electric Transmission Power Grids –** greater system reliability and redundancy with IPL booster pump stations on alternate circuits from existing TRWD booster stations
d. **Lake Pump Station Intakes and Wetwells –** improved hydraulic performance and efficiency and biofilm and mussel control
e. **Booster Pump Stations** – three boosters versus two boosters allows for more efficient IPL operations, phasing based on demands and future source locations
f. **Booster Suction Reservoirs –** earthen reservoirs versus tanks provide additional volume for IPL system recovery/adjustments following power outages and normal operation time of day pumping (energy efficiency)
g. **Variable Frequency Drives (VFD) –** all pump units equipment with VFDs versus across-the-line start improves energy efficiency, reduces energy cost, and essential for effective time-of-day delivery
h. **Pipeline Alignment and Profile –** deep tunnels versus open cuts yields improved hydraulic performance (gravity) and energy reduction
i. **Pipeline Friction Factor and Diameter–** increased system life cycle efficiency
j. **Midlothian Balancing Reservoir –** Provides time-of-day delivery capability and water treatment plant contingency/emergency supply during IPL outages

Tarrant Regional Water District/ City of Dallas

Amendments 3 and 4 of Phase 1 of the Raw Water Transmission System Integration Study Report No. 3

July 2010

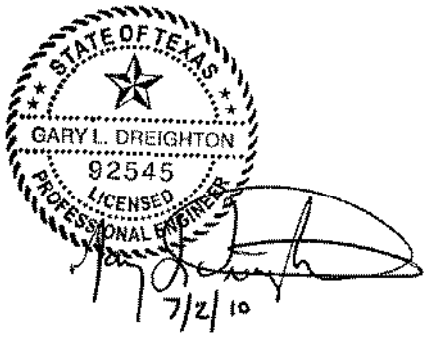
CDM In Association with: FREESE AND NICHOLS

Geo-Marine, Inc.

Tarrant Regional Water District/ City of Dallas

Amendments 3 and 4 of Phase 1 of the Raw Water Transmission System Integration Study Report No. 3

July 2010



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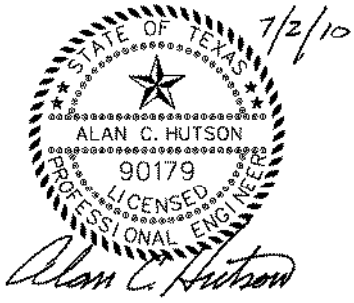

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Executive Summary

ES 1 Background and Purpose

The Tarrant Regional Water District (TRWD) and the City of Dallas have partnered to explore the feasibility of an integrated approach to bring additional water into the Dallas and Tarrant Regional Water District service areas. This project's planning level phase, the "Raw Water Transmission System Integration Study: Phase 1", is completed with this final report. It has been a business case evaluation and project viability assessment, meaning that it is focused on identifying fatal flaws (if present) and comparing independent projects to system integration. Because the project has been found viable and the business case sufficiently strong to recommend system integration, Dallas and TRWD intend to enter into an agreement to share conveyance infrastructure and water and begin the design and construction process.

Part of the Integrated Pipeline (IPL) Project planning phase is selection of a pipeline route (a pipeline centerline with a roughly 450' buffer based primarily on desktop analysis methods). Pipeline alignment planning is based on an engineering assessment typically broken down into (3) phases: Corridor Selection, Route Selection, and Alignment Selection. Each phase of study is progressively more detailed as one moves from the corridor selection phase to the alignment selection phase. This process helps identify the pipeline alignment that best meets performance criteria established by the Owner and design team, meets requirements of the NEPA (National Environmental Policy Act) process, and refines project definition on a path parallel to other project planning. This study represents the Route Selection phase of that process.

The purpose of this draft report is to present the final recommended pipeline route and preliminary facility sites (pending full operations study) for the Integrated Pipeline project (IPL). The selected pipeline route will be refined to a final alignment in the next phase of work, which will also include a full Operations Study that will finalize selection of facility sites.

Because Dallas is reviewing multiple alternatives to bring water into their system from the IPL (see *Dallas Delivery Location Analysis* Technical Memoranda), this report does not analyze, cost, or recommend a pipeline route for Segment H, the connection between the IPL and Dallas' delivery point. However, project cost including Segment H is included in Appendix M only for reference purposes and is not included elsewhere in the report.

The overall Integrated Pipeline has been subdivided into reaches, designated A through I; the recommended pipeline route is shown in **Figure ES-1** and **Table ES-1** provides segment descriptions and design flow rates. Segments were defined based on the proposed design flow rate of the pipe and based on cost allocation methodologies described in the October 2009 *Amendments 3 and 4 of Phase 1 of the Raw Water Transmission System Integration Study Report No. 1*.

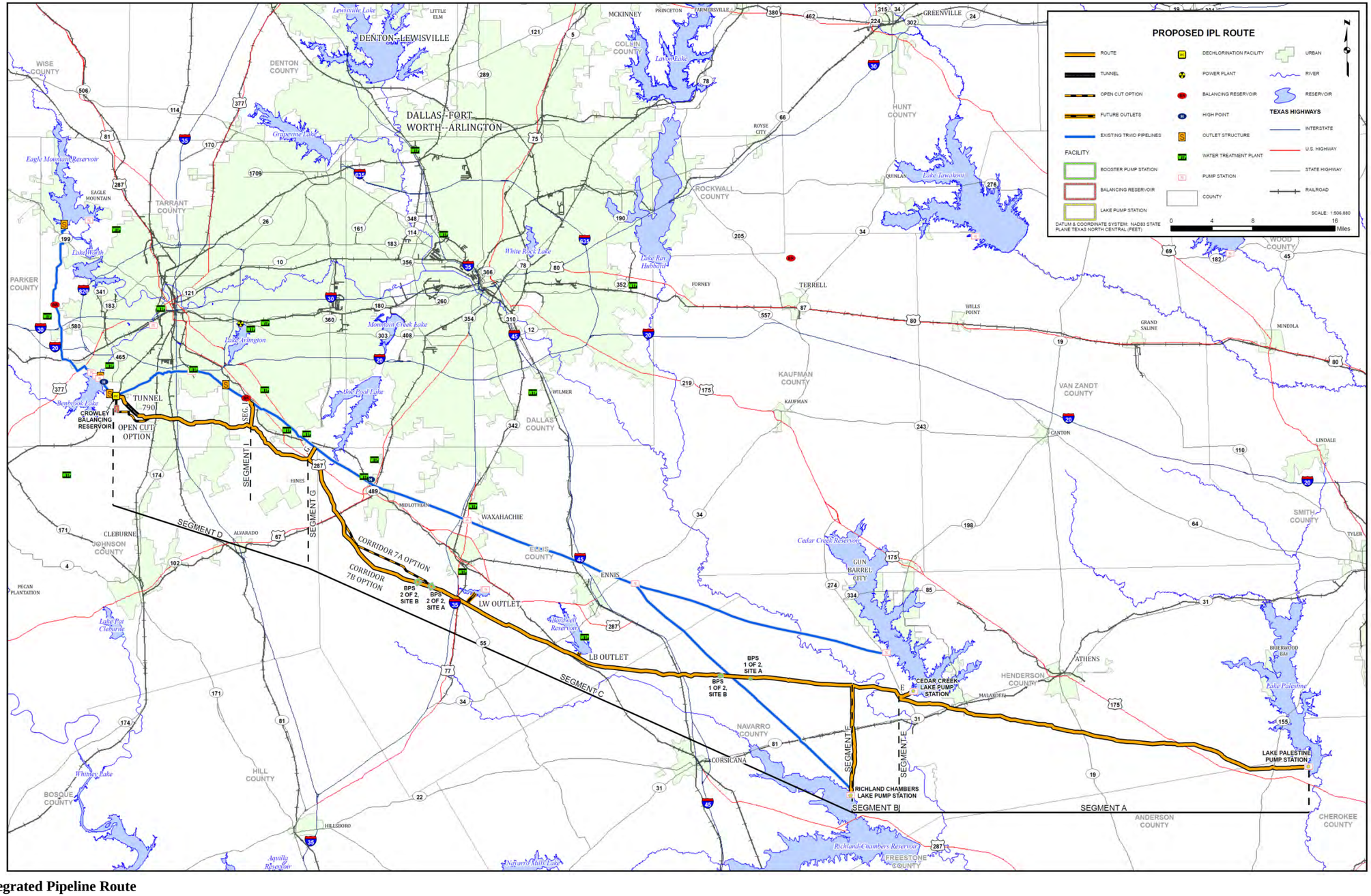

Figure ES-1. Integrated Pipeline Route

Pumping facilities selected for the Integrated Pipeline consist of three new intake pump stations (Lake Palestine Intake, Cedar Creek Intake, and Richland-Chambers Intake) and two booster pump stations as shown in Figure ES-1 above.

Table ES-1 Segment Descriptions

Segment	From	To	Design Flow Rate (MGD)	Potential Cost Allocation
A	Lake Palestine	Cedar Creek Connection	150	100% Dallas[1]
B	Cedar Creek Connection	Richland-Chambers Connection	277	Joint
C	Richland-Chambers Connection	Bachman Take-off Point	347	Joint
D	Bachman Take-off Point	Connection to Benbrook Pipeline	197	100% TRWD
E	Cedar Creek Reservoir	Connection to the Main Pipeline	127	100% TRWD
F	Richland Chambers	Connection to the Main Pipeline	70	100% TRWD
G	Main Pipeline	Existing TRWD Lines	347	Joint
I	Connection to Main Pipeline	Kennedale Balancing Reservoir	197	100% TRWD

In order to keep the main report body more concise, many of the analyses supporting pipeline route selection are contained in the appendices. The main report is structured as follows:

- Section 1 – Introduction
- Section 2 – Route Selections and Descriptions
- Section 3 – Facility Site Selection (lake pump stations and booster pump stations)
- Section 4 – Hydraulic Evaluation
- Section 5 – Costs
- Section 6 – Recommendations
- Section 7 – References

Appendices contain results of the following studies that support the evaluation of corridors:

- Integrated vs. Independent Project Costs
- Conflict Analysis
- Route Maps
- Phasing Analysis (in draft outline form as of the date of this draft report submittal)

Several workshops, technical memoranda and reports were used to help develop the recommendations noted in this report. Some of these documents are listed below:

- Amendments 3 and 4 of Phase 1 of the Raw Water Transmission System Integration Study Report No. 1.
- Amendments 3 and 4 of Phase 1 of the Raw Water Transmission System Integration Study Report No. 2.

[1] Under the existing form of the Team Charter, TRWD will share only in the cost for purchase of additional right of way in this segment.

- Corridor Selection Criteria Technical Memorandum
- Hydraulic Design Criteria Technical Memorandum
- Infrastructure Sizing Technical Memorandum
- Southern Re-route (Corridor 7) Comparison Technical Memorandum

ES 2 Recommendations and Conclusions

- Using primarily desktop analysis methods, this analysis recommends the pipeline route and facility sites as shown in Figure ES-1
- It is recommended that a 2 Booster Pump Station configuration be selected at this time for refinement and verification during the Conceptual Design and Operations Study phase.
- This report recommends that a deep tunnel be constructed through the Benbrook high point (near Crowley) for reasons of life-cycle cost reduction through pumping energy savings. This recommendation will also be refined and verified during the Conceptual Design and Operations Study phase.
- The following pipe sizes are recommended based on current system operations modeling:

Segment	***Design Flow***	***Nominal Pipe Size***
	(MGD)	***(Inch)***
A	150	84
B	277	108
C	347	108
D	197	84
E	127	72
F	70	66
G	347	108
H	150	84
I	197	84

- Current cost analyses conclude that significant cost savings will be realized by developing an integrated raw water transmission system as compared to developing independent systems, savings in the range of $375 to $443 million in capital cost and roughly $1 to $1.5 billion in present worth 50-year life-cycle cost.
- Total project (without Segment H) capital costs using the recommended pipeline route and current configuration is approximately $1.47 billion (in 2009 dollars). 100-year life-cycle present worth is approximately $3 billion.
- The detailed cost spreadsheets and tables noted in this report have been validated by the 0% Value Engineering (VE) team. Most of the recommendations and cost estimating methodology suggestions were adopted and incorporated into this final report subsequent to the VE workshops held during the week of May 17, 2010. However, because some analyses were completed prior to the VE, many comparative cost estimates rely on older

methodology. This is most evident in the appendices, which contain results from analyses completed prior to the VE.

ES 3 Next Steps

This report concludes the planning phase of the Raw Water Transmission System Integration Study and leads into the conceptual design phase of the Integrated Pipeline Project. The following next steps are recommended.

With the conclusion of this route selection, the pipeline analysis will transition from a desktop route study to a final surveyed alignment which will be used in the final design of all segments. To date, the corridor and route studies have been primarily "desktop" studies using aerial photography, available records and databases, and readily available property data. In order to refine the route to the final alignment, significant field work, survey, landowner research, engineering, environmental, and archeological research, will be required.

A full Operations Study will accompany pipeline routing and facility site selection in the conceptual design phase. This study will define system operations, hydraulics, and component operations under a variety of operating conditions, such as seasonal variations in water demand, maintenance and contingency operations, and etc. This operations study and accompanying cost analysis will refine and either verify or modify recommendations made in this report, which were based on one set of baseline operating conditions.

Project design standards are currently under development and will also be finalized in the subsequent project phase. These standards will be the basis for final design.

Section 1
Introduction and Purpose

1.1 Project Background

The Tarrant Regional Water District (TRWD) and the City of Dallas have partnered to explore the feasibility of an integrated approach to bring additional water into the Dallas and Tarrant Regional Water District service areas. This project's planning level phase, the "Raw Water Transmission System Integration Study: Phase 1", is completed with this final report. It has been a business case evaluation and project viability assessment, meaning that it is focused on identifying fatal flaws (if present) and comparing independent projects to system integration. Because the project has been found viable and the business case sufficiently strong to recommend system integration, Dallas and TRWD intend to enter into an agreement to share conveyance infrastructure and water and begin the design and construction process.

Part of the Integrated Pipeline (IPL) Project planning phase is selection of a pipeline route. This work was completed in two steps. The first step was to select facility (pump stations, outlets, tanks, etc.) sites and a pipeline corridor, defined as a pipeline centerline with a ½ mile buffer on either side within which the final pipeline will be constructed. This report describes the analysis to refine the pipeline corridor to a route, a pipeline centerline within the corridor with a smaller buffer and greater certainty, though still based on desktop analysis methods. During the corridor selection phase of the project, several corridor alignments were compared based upon 5 principal criteria:

- Schedule
- Environmental Constraints
- Cost (capital, energy, and life cycle)
- Constructability
- Performance (hydraulic, operational)

A comparative analysis of multiple corridors was developed and presented in *Amendments 3 and 4 of Phase 1 of the Raw Water Transmission System Integration Study Report No. 2.* After the submittal and review of Report No. 2, an additional corridor was identified as a viable alternative. The IPL team prepared an additional comparative analysis between the newly defined corridor (Corridor 7) and the corridor recommended and selected in Report No. 2 (Corridor 1/5 hybrid).

A workshop meeting was held on March 16, 2010 to make four decisions: 1) select the final preferred corridor; 2) select the number of booster pump stations; 3) recommend the lowest life-cycle cost pipe size; and 4) decide if deep tunnels would be constructed through Midlothian and/or the Crowley portions of the pipeline. Decisions on items 1 through 4 were made during the meeting with an understanding that decisions 2 through 4 will require confirmation during the operations study in the next phase of the IPL project.

In that meeting, comparisons between Corridor 1/5 hybrid and Corridor 7 were made based on the five principal criteria described above and Corridor 7b was selected as the preferred corridor. Environmental reconnaissance helicopter flights along the selected corridor began the following week and all cost estimates, hydraulic calculations and other relevant tasks moved forward based on the alignment of Corridor 7b.

1.2 Report Purpose and Overview

The overall Integrated Pipeline has been subdivided into reaches (designated A through I and as shown in **Figure 1-1**) depending on the proposed design flow rate of the pipe and based on cost allocation methodologies described in the October 2009 *Amendments 3 and 4 of Phase 1 of the Raw Water Transmission System Integration Study Report No. 1*.

The purpose of this report is to present the final recommended pipeline route and preliminary facility sites (pending full operations study) for the Integrated Pipeline project (IPL). The selected pipeline route will be refined to a final alignment in the next phase of work, which will also include a full Operations Study that will finalize selection of facility sites.

Because Dallas is reviewing multiple alternatives to bring water into their system from the IPL (see *Dallas Delivery Location Analysis* Technical Memoranda), this report does not analyze, cost, or recommend a pipeline route for Segment H, the connection between the IPL and Dallas' delivery point.

In order to keep the main report body more concise, much of the analyses supporting pipeline route are contained in the appendices. The main report is structured as follows:

- Section 1 – Introduction
- Section 2 – Route Selection and Descriptions: The purpose of this section is to describe the pipeline segments of the IPL route.
- Section 3 – Facility Site Selection: Preliminary facility site selections are discussed in this section of the report; including lake pump stations, booster pump stations, storage tanks, and outlet structures.
- Section 4 – Hydraulic Modeling: Prior assessments focused on the existing transmission system as well as the proposed (integrated system). Peak capacities of the proposed transmission pipeline were established along with general alignment corridors. This section focuses on the selected IPL configuration for peak flow conditions including sizing of the pipelines and capacity/power requirements for the pumping stations. Specific routes and pump station locations have been identified and facility sizing has been established for the IPL route. This section also addresses hydraulic criteria, analysis tools and approach associated with selected IPL configuration.
- Section 5 – Costs: This section describes the main IPL project cost analysis and the current basis for the conceptual level opinion of probable capital cost and life cycle cost. Project milestones such as the conceptual and final design will generate more detail so that estimates improve as project definition improves. This section first describes parameters used in the cost analysis and its methodology. Next, capital cost estimates are summarized for each segment and facility, followed by life-cycle cost estimates.

- Section 6 – Summary of Selected Route: This section of the report provides a comprehensive tabular view of the main IPL route and the quantitative and qualitative descriptive fields associated with the IPL configuration.
- Section 7 – References: This section includes a comprehensive list of references cited in the report.

Appendices contain results of the following studies that support the selection of the IPL route:

- Redundancy Study and Potential Power Suppliers
- Geology and Geotechnical Considerations
- Environmental and Cultural Resources Analysis
- Permitting Inventory
- Infrastructure Sizing
- Cost Spreadsheets
- Risk Analysis
- Preliminary Surge Analysis
- Route Maps
- Integrated vs. Independent Project Costs
- Conflict Analysis
- Route Maps
- Phasing Analysis
- Project Opinion of Probable Cost including Segment H

1.3 Methodology

Selection of the IPL pipeline route and facility sites began with a pipeline corridor selection, detailed in *Amendments 3 and 4 of Phase 1 of the Raw Water Transmission System Integration Study Report No. 2*. Report 2 presented multiple pipeline corridor options and the final preferred corridor was selected based on a methodology described in Sections 7 and 8 of that report. Starting with the final selected corridor, a detailed desktop conflict analysis addressing qualitative and quantitative factors was used to select the preferred IPL route, a refinement to the roughly one-half mile wide corridor. Details of the conflict analysis are noted in Appendix J of this report.

1.4 Key Terms

Alignment: here defined as a final pipeline centerline that will be used in construction bid packages. This will be defined in conceptual design and may be slightly refined throughout the final design phases.

Corridor: here defined as a pipeline centerline with a ½ mile buffer on either side within which the final pipeline will be constructed, selected based on primarily desktop analyses..

Criteria/Evaluation Criteria: here defined as the standard by which the corridors are ranked based on project objectives.

Integrated Pipeline: The raw water transmission system integrating TRWD and Dallas supply transmission from Lake Palestine and Cedar Creek and Richland-Chambers Reservoirs.

Route: here defined as a pipeline centerline within the corridor with a smaller buffer and greater certainty than a corridor, though still based on primarily desktop analysis methods

Section 2
Route Selection and Descriptions

This section describes the recommended pipeline route for the Integrated Pipeline Project (IPL). The section is divided into 8 parts that describe Segments A through I plus a final part that describes next steps in the process. Dallas' branch line to their delivery point at either Bachman Lake or Joe Pool Lake, defined as Segment H, will not be discussed in this draft report as the final delivery point has not been determined at this time. Segment G is evaluated here but this Segment may be eliminated in future studies depending on the Dallas delivery location and results from the full operations study in the next phase of work.

For purposes of the analysis, the pipeline was divided into various pipeline segments depending on the proposed design flow rate of the pipe and in consideration of potential ownership and cost allocations between TRWD and Dallas. The **Table 2-1** lists the various pipeline segments and design flow rates. Pipe diameters as listed here and referenced hereafter are pending full Operations Study results to set their final diameters.

Table 2-1. IPL Segment Descriptions with Anticipated Pipeline Diameter, Design Flow Fate and Cost Allocation

Segment	From	To	Pipeline Diameter	Flow Rate (MGD)	Potential Cost Allocation
A	Lake Palestine	Cedar Creek Connection	84"	150	100% DWU[1]
B	Cedar Creek Connection	Richland-Chambers Connection	108"	277	Joint
C	Richland-Chambers Connection	Bachman Take-off Point	108"	347	Joint
D	Bachman Take-off Point	Connection to Benbrook Pipeline	84"	197	100% TRWD
E	Cedar Creek Reservoir	Connection to the Main Pipeline	72"	127	100% TRWD
F	Richland-Chambers	Connection to the Main Pipeline	66"	70	100% TRWD
G	Main Pipeline	Existing TRWD Lines	108"	347	Joint
H	Existing TRWD Lines	Bachman WTP	84"	150	100% DWU
I	KBR Take-off Point from Main Pipeline	Kennedale Balancing Reservoir	84"	197	100% TRWD

The route was selected on the best information available to the route selection team without the benefit of accessing property or talking with various entities with jurisdiction along the pipeline route. A route width of 450 feet wide was selected to bracket the landowners that would be contacted for survey access permission. Once the property is accessible, this 450 foot buffer on the route centerline will be cleared for environmental and archeological conflicts. Engineering evaluations and discussions with landowners may bring about the need to deviate the pipeline from the current route centerline. The goal will be to remain in the 450 foot wide buffer;

[1] Under the existing form of the Team Charter, TRWD will share only in the cost for purchase of additional right of way in this segment.

however, it is anticipated that some additional areas will require access permission and environmental clearance.

Mapping

A map of the pipeline route with each segment label may be found on the following page, **Figure 2-1**. A detailed mapbook of the pipeline route at a scale of 1" = 500' may be found in Appendix K. The mapbook illustrates the pipeline route centerline with a solid orange line and the proposed 150' easement shown with dashed orange lines. Property lines are shown in white. The main pipeline has been stationed beginning at Lake Palestine and ending at the Benbrook Connection in southwest Tarrant County.

Classifications

For each of the routes discussed in this report, the route was classified as to the land type. A length for each land type was determined to assist with cost estimating and to evaluate the construction difficulty for the various routes. A brief definition of each classification used to classify the routes is below.

1. **Rural**: The pipeline route encompasses a majority of undeveloped or farmland and there are only sporadic structures in the area near the route. This classification has been divided into the following sub classifications
    a. Pasture: The easiest construction with very few limitations or restrictions
    b. Croplands: Also easy construction; however, land costs are usually higher due to crop replacement and sensitivity of easement restoration (for example, no rocks left and 2' of top soil be replaced).
    c. Wooded: The contractor will have to add cost to clear trees and work space will be reduced to half the ROW width in this area to reduce construction impact.
2. **Urban**: The pipeline enters a more congested area that has the potential to slow down the pipe laying crew due to limited work space and conflicts with roads, existing utilities, and other structures. This classification has been divided into the following sub classifications
    a. Light Urban: The pipeline route encompasses a majority of area that contains some low- to medium-density subdivisions, but still has a large amount of open space. If there are existing roadways along the route, the roads are rural sections or large open parkways with landscape buffers and/or large medians.
    b. Medium Urban: The pipeline route encompasses a majority of area that has high to medium-density subdivisions throughout, some retail and commercial. There is some open space and/or large parkways with landscape buffers and/or medians.
    c. Heavy Urban: Dense development including residential, retail, and commercial and little to no setback from the roads.

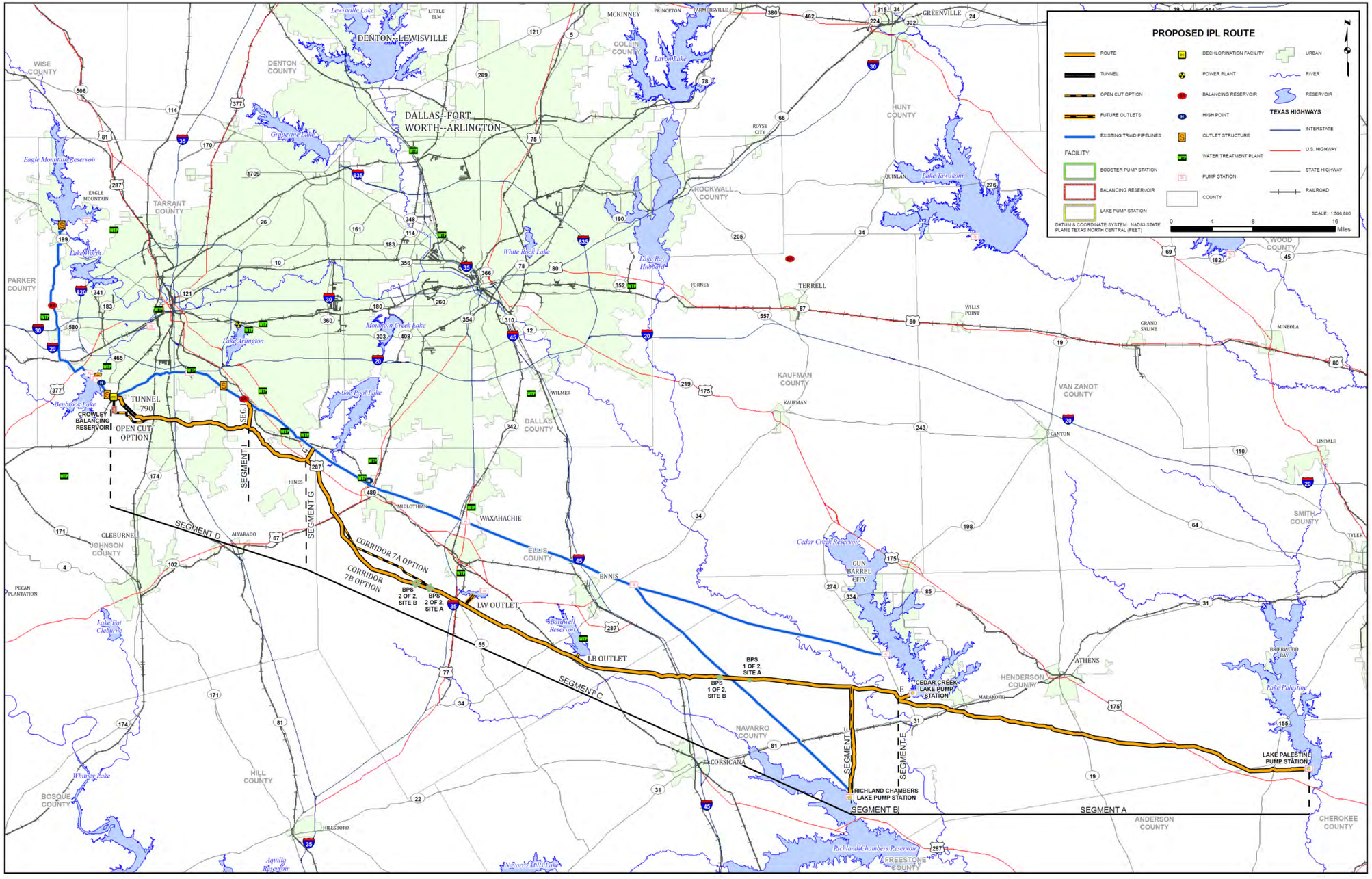

Figure 2-1. Route Overview

3. **Open Cut Crossings**: Crossings that can be open-cut without a tunnel
    a. Minor Road: These are typical county roads and some city streets with lower vehicle counts.
    b. Water Body: Small water bodies such as creeks or ponds that can be dewatered temporarily to facilitate the installation of the pipeline.
4. **Tunnels**:
    a. Crossing Tunnels: This length of the route crosses topographic features or existing facilities such as roadways, railroads, or major utilities that are assumed will need to be tunneled underneath during construction due to the heavy impact that pipeline construction would have on the area. For this stage of the study all existing highways and major roadways were assumed to be tunneled.
    b. Deep Tunnels: In areas of heavy urbanization a deep tunnel, perhaps 40 feet to 100 feet deep, was studied to avoid conflicts. Deep tunnels may also be utilized to reduce power costs by lowering the controlling high point of the proposed pipeline.

Easement Assumptions

Unless specifically noted otherwise, all routes were studied for a 150 foot wide permanent easement. This width allows for the initial construction of one pipeline and future construction of two more pipelines for a total of three pipelines within the easement. It should be noted that certain segments may not need to be planned for three pipelines and a 150 foot width; however, for cost estimating and route selection purposes, a 150 foot wide easement has been assumed. The final easement widths should be determined in the conceptual design phase based on the number of planned pipelines, the design basis of the pipeline and the agreed upon easement restrictions.

2.1 Segment A – Palestine to Cedar Creek

2.1.1 Overview

The beginning point for Segment A is the Lake Palestine Pump Station, which is north of The Meadows subdivision on the southwest side of Lake Palestine. A description of the Lake Palestine Pump Station site is included in Section 3. Segment A is the easternmost segment of the proposed Integrated Pipeline. The route begins at the proposed Lake Palestine Pump Station site and ends at the junction of Segment A and Segment E, southwest of Cedar Creek Reservoir. Refer to **Figure 2-2** for an overall map of Segment A.

This segment of the route has a design capacity of 150 MGD. Sizing of the pipeline is discussed in Chapter 4 of this report. The proposed route is within the boundaries of Henderson County, except for a small portion of the corridor near Lake Palestine which is in Anderson County.

Table 2-2 shows the construction classification for segment A. As seen in the table, Segment A is largely comprised of rural land with 97% of the segment being either pasture or wooded.

Table 2-2. Segment A Route Classification

	Major Classification	Length (LF)	Detailed Classification	Length (LF)
Open Cut	Crossings	2,441	Minor Road	677
			Water Body	1,764
	Rural	213,869	Pasture	117,970
			Cropland	-
			Wooded	95,899
	Urban	2,747	Light Urban	2,747
			Medium Urban	-
			Heavy Urban	-
Tunnel	Crossing Tunnel	1,337	Railroad	142
			River	-
			Major Road	1195
	Deep Tunnel	-	Deep Tunnel	-
Total Length - Segment A				**220,394**

The following facilities and connections are located within Segment A:

- The Lake Palestine Intake Pump Station is located on the most eastern portion of the IPL. The pump station is discussed in detail in Section 3 of this report.
- Segment E Connection is located at the most western point of Segment A, at the junction of Segment A and B. Segment E is addressed as a separate line segment later in this report section.

A proposed outlet to Cedar Creek Reservoir was originally planned for this pipeline segment near the east end of the dam embankment. TRWD prefers to make the line segment from Cedar Creek to the main pipeline, Segment E, bi-directional to serve as a possible outlet into Cedar Creek if necessary.

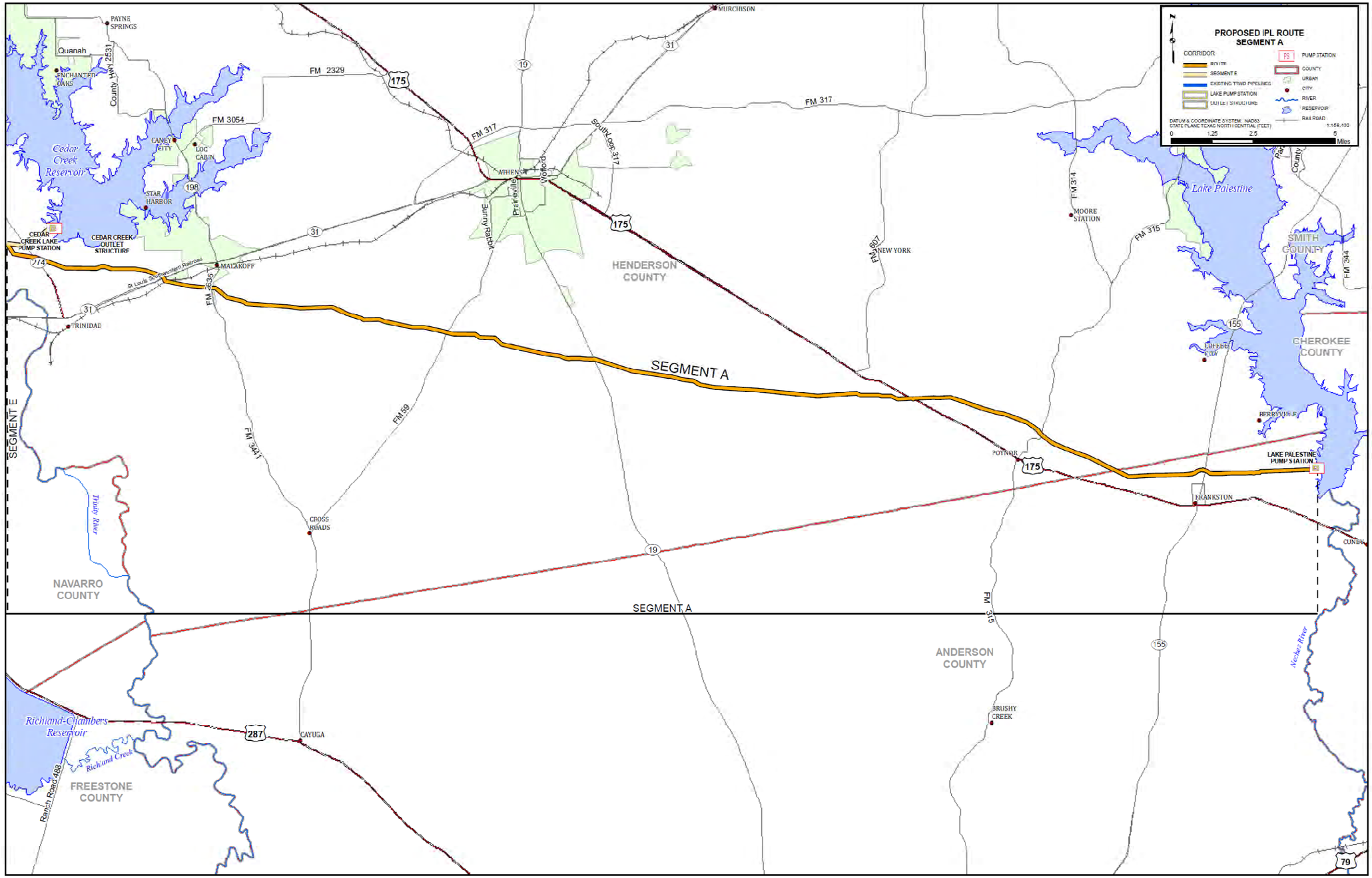

Figure 2-2. Segment A

2.1.2 Route Description and Conflict Analysis

From the proposed Lake Palestine Pump Station, Segment A proceeds to the west-southwest, and then follows along the north side of CR 307. Next, the route moves to the south side of CR 305. The route then passes to the north of Frankston High School. The corridor study placed the proposed pipeline just north of Frankston High School, but it was discovered that the high school has added multiple tennis courts where the route was originally located. Thus the route was moved further north due to the Frankston Riding Center and a car dealership just north of the high school and tennis courts. The following photo (**Figure 2-3**) shows the Frankston High School area facing east. In the photo, the high school, tennis courts, riding center and the car dealership building can be seen. The route will pass in the area to the north of the car dealership.

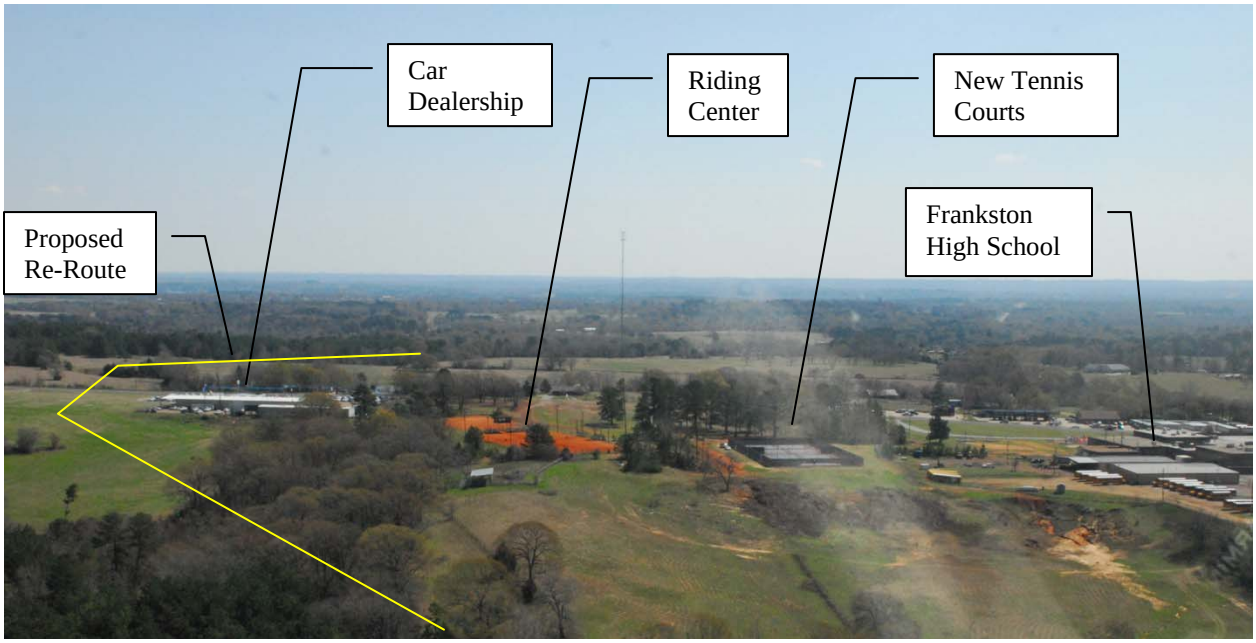

Figure 2-3. Frankston High School Area

Two miles west of Frankston High School, the corridor proceeds northwest. The route passes near LaPoynor High School. A conflict analysis was conducted for the area around the high school. Two options were studied for this area, a northern option and a southern option. (See Appendix J for the complete memorandum and exhibits of the conflict analysis.) The northern option was chosen because it is the shorter, less expensive, and impacts fewer parcels. In addition, the northern option avoided the lakes and water crossings associated with the southern option.

After the route passes north of LaPoynor High School, the route proceeds west-northwest for approximately 23 miles, routing through mainly rural pastures and wooded areas. The route passes roughly five miles south of Athens. After the route crosses the St. Louis Southwestern Railroad and US 31 near Malakoff, the route turns to the northwest and passes south of the Cedar Creek Reservoir. Three options in this area were analyzed. The northern route is the shortest option, but contains six water crossings while the central option has only two creek crossings.

Therefore, the central option was chosen as the best route. (See Appendix J for the complete memorandum.

Segment A ends at the Segment E junction. The Segment A route is approximately 41.7 miles long. **Table 2-3** is a summary of all the areas in which a conflict analysis was performed for Segment A and summarizes the decisions made.

Table 2-3. Conflict Analysis

Conflict Name	ID Number	Decision
CR 301	A1	The northern option is most direct with the least amount of bends.
LaPoynor HS	A2	Routed north due to shortest length and fewest number of parcels impacted.
Hallmark Lake	A3	The southern option requires the shortest length and is less costly.
Cedar Creek	A4	The central option requires the fewest number of water crossings.

Note: Conflicts A1 and A3 were both small conflicts with severed parcels. They were analyzed to minimize parcel severance, but ultimately the most direct routes were chosen; see Appendix J.

2.1.3 Hydraulics

There are several high points located in Segment A that could affect the hydraulics of the system. The highest point reaches a ground elevation of 550 feet MSL while several others reach a ground elevation of 530 feet MSL. Depending upon the location and elevation of the tank/reservoir at BPS 1 of 2, these high points could create an operational issue each time the booster pump station is turned off. The high points will drain toward the BPS storage reservoir with the potential of overflowing the reservoir. In addition, the drained portion of the line will need to be filled slowly each time the system is started to carefully evacuate air. This problem can be solved by lowering the high points or locating the BPS 1 of 2 site to match the reservoir elevation with the pipeline high points. The 550 foot high point can be deep cut for about 1,000 feet near station 810+00 to set the top of pipe at elevation 525 feet MSL. The hydraulics will be discussed further in the facility selection portion of the report and in Section 4.

2.1.4 Crossings

The roads and railroads that will require tunneling on Segment A are listed in **Table 2-4**.

Table 2-4. Segment A Major Crossings

Major Highways	FM Highways	RR/River Crossings
S.H. 155	FM 315	St. Louis Southwestern Railroad
U.S. 175	FM 1615	
S.H. 19	FM 753 (2)	
U.S. 21	FM 59	
S.H. 274	FM 2636 (2)	

Segment A also has four major electrical transmission line crossings that will likely require a crossing permit or agreement.

2.1.5 Environmental

For a detailed analysis of creek crossings see the environmental report in Appendix C. **Table 2-5** is a summary of the environmental areas crossed by Segment A.

Table 2-5. Segment A Environmental Conflicts

	Number	Length, ft	Area, acre
Perennial Creek Crossings	16	3,044	
Intermittent Creek Crossings	68	15,181	
Wetlands			6
Upland Forest			110
Bottomland Hardwoods			33

2.2 Segment B

2.2.1 Overview

Segment B is defined as the pipe segment between the Cedar Creek Pipeline Connection (Segment E) and the Richland-Chambers Pipeline Connection (Section F). Refer to **Figure 2-4** for a map identifying Segment B. Segment B will be sized to accommodate 150 MGD from Lake Palestine and 127 MGD from Cedar Creek Reservoir for a total combined capacity of 277 MGD. The preliminary studies show this pipe segment will be 108-inches in diameter.

Table 2-6 is a summary of the construction classifications for Segment B. As seen in the table, Segment B is largely comprised of rural land with 98% of the segment being either pasture or wooded.

Table 2-6. Segment B Route Classification

	Major Classification	Length (LF)	Detailed Classification	Length (LF)
Open Cut	Crossings	215	Minor Road	131
			Water Body	84
	Rural	25,591	Pasture	18,419
			Cropland	-
			Wooded	7,172
	Urban	-	Light Urban	-
			Medium Urban	-
			Heavy Urban	-
Tunnel	Crossing Tunnel	353	Railroad	-
			River	353
			Major Road	-
	Deep Tunnel	-	Deep Tunnel	-
Total Length - Segment B				**26,159**

There are no proposed facilities situated within the Segment B route, but the following are the connections located within Segment B:

- Segment E Connection from Cedar Creek Lake (at the junction of Segment A and B)
- Segment F Connection from Richland Chambers Lake (at the junction of Segment B and C)

Each of the above connections are addressed as separate segments within this section of the report.

2.2.2 Route Description and Conflict Analysis

Segment B is a short rural segment without any delivery points. The route for Segment B begins at the Segment A-E-B connection and extends north-northwest for half a mile and then proceeds west-northwest through a rural semi-wooded area. Approximately 2.5 miles west-northwest of the connection to Segment E the segment crosses the Trinity River. It is assumed the River Crossing will be tunneled. The next significant element of the pipeline is the connection to Segment F where Segment B ends. The overall length of the Segment B route is 5.0 miles.

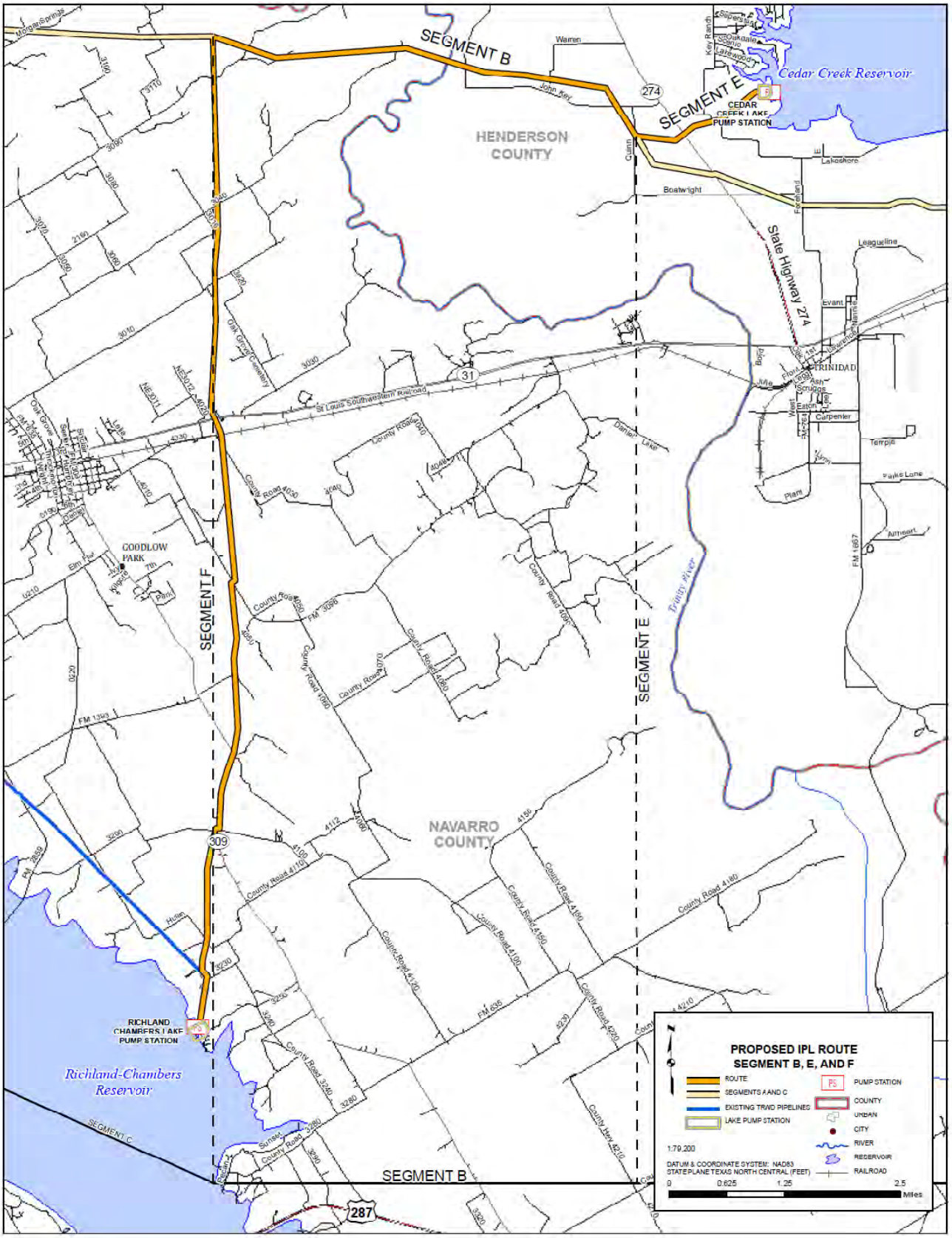

Figure 2-4. Segments B, E, & F

2.2.3 Crossings

Segment B has the one major crossing of the Trinity River, and does not have any major road crossings. Geotechnical borings will be required for the crossing of the Trinity River for tunnel design. The original corridor crossed the Trinity River slightly further south, but the route was moved north to move away from a rural subdivision and out of an old river oxbow to avoid potential poor soil conditions. **Figure 2-5** shows a picture of the Trinity River looking south. It is anticipated that the pipeline will cross the river in the straight run of the river in the foreground. It is anticipated that this river crossing will be constructed with a tunnel from approximately 20-40 feet beyond the tops of banks.

Figure 2-5. Trinity River Crossing (Facing South)

2.2.4 Environmental

For a detailed analysis of creek crossings and other environmental impacts see the environmental report in Appendix C. **Table 2-7** is a summary of the environmental areas crossed by Segment E.

Table 2-7. Segment B Route Environmental Crossings

	Number	Length	Area (ac)
Perennial Creek Crossings	-	-	
Intermittent Creek Crossings	4	766	
Wetlands			14
Upland Forest			3
Bottomland Forest			18

2.3 Segment C

2.3.1 Overview

The beginning point for Segment C is located west of Cedar Creek Reservoir where the pipeline segments B, C, and F all intersect while the end of Segment C is at the connection to Segments D and G. See **Figure 2-6** for a map showing the entire segment. Segment C bears west from the F and B connection and travels south of Bardwell Lake crossing I-45 midway. From Bardwell Lake the route turns northwest passing south of Lake Waxahachie, crossing I-35E and arriving at a point to the south of hill country near Midlothian. The hill country south of Midlothian acts as a turning point for the route as it heads more northerly towards the ending point at the D and G connection near the intersection of S.H. 360 and 287. Segment C is the longest IPL segment accounting for 42% of the entire route.

The final route preferred for Segment C changed significantly from the corridor (Corridor 5) selected in the previous corridor study. During the detailed analysis of the corridor, several challenges presented themselves including a wildlife refuge, several urban areas near Midlothian and significant impacts to USACE property around Lake Bardwell. For this reason, other corridors (Corridor 6 & 7) were proposed, studied and compared against Corridor 5. An evaluation of the corridors led the owners to choose the southern Corridor 7 as it missed USACE property and is a more rural route. In addition, a specific corridor, identified as Corridor 7b, that routed south of Midlothian was found to be more advantageous from an energy savings standpoint as it missed several highpoints. A detailed analysis comparing the above corridors may be found in Appendix J as C11. Corridor 7b was preferred by the owners and is described hereafter. **Table 2-8** summarizes the breakdown of this segment:

Table 2-8. Segment C Classification

	Major Classification	Length (LF)	Detailed Classification	Length (LF)
Open Cut	Crossings	1,813	Minor Road	1,115
			Water	698
	Rural	310,388	Pasture	166,885
			Cropland	85,975
			Wooded	57,528
	Urban	14,249	Light Urban	14,249
			Medium Urban	0
			Heavy Urban	0
Tunnel	Crossing Tunnel	2,938	Railroad	767
			River	0
			Major Road	2171
	Deep Tunnel	0		
Total Length - Segment C				**329,388**

Both booster pump stations on the IPL are located within segment C. The first or upstream BPS is situated near the RC pipeline crossing. The second or downstream BPS is west of I-35E near FM 66. Both of the BPS sites are presented with two options in section 3.

There are five proposed connections within Segment C.

1. The Segment F Connection is located at the beginning of Segment C.
2. **RC Cross-Connection**: A connection to the existing RC pipeline will be made where the RC pipeline and the IPL cross. This intersection is just east of FM 1603 near Chatfield. The connection adds reliability as it allows several bypassing and pumping options. The connection also allows deferment of Segment F construction.
3. **Bardwell Reservoir Outlet**: Approximately 15,000 feet east of the State Highway 34 crossing, a connection will be made for the Bardwell Lake outlet. The outlet is planned as a future connection and is not anticipated to be built with the IPL. The future connection will be approximately 2,570 feet long. It will approach the lake from the south, west of Bardwell Dam. Approximately 1,400 feet of the connection will cross USACE property thus requiring an easement from the USACE. The City of Waxahachie currently uses Lake Bardwell as a water source and can pump Bardwell water to Lake Waxahachie or to their WTP. The city has plans to expand their WTP from 15 MGD to 27 MGD. This connection will help accommodate the city's future demands.

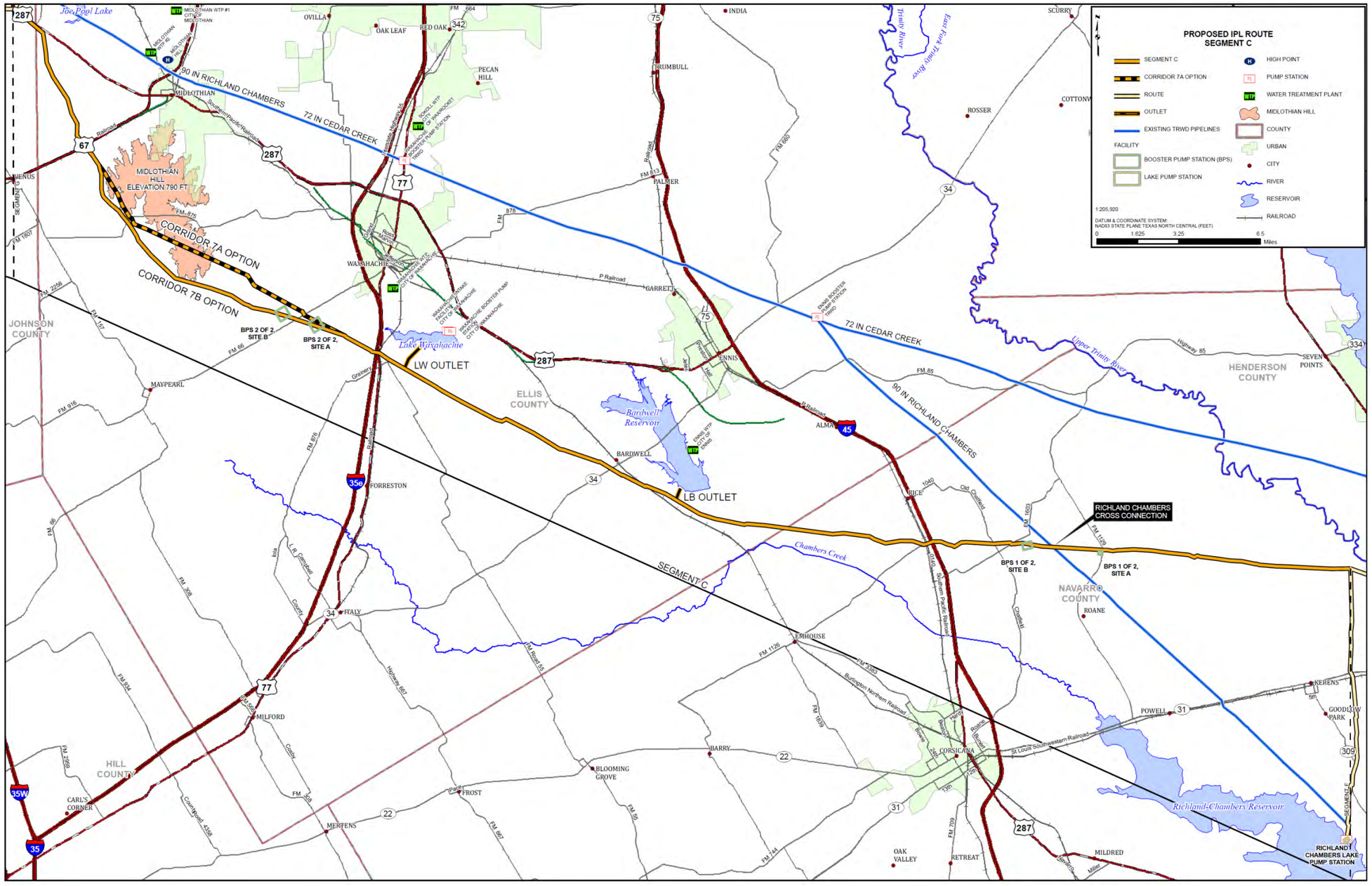

Figure 2-6. Segment C

4. **Lake Waxahachie Outlet**: A little over a mile east of I-35E will be a future connection to Lake Waxahachie. The outlet will be an approximate 7,194 feet in length approaching the lake from the south. Similar to the Bardwell connection, this connection will contribute to the supply for the city of Waxahachie. The connection will not require USACE permitting, but will require easements through private lake front property. The lake is owned by the Ellis County Water Control and Improvement District No. 1.
5. The Segment G connection defines the end of Segment C. Segment G delivers 150 MGD to Dallas and is addressed separately as a segment in this section of the report.

2.3.2 Route Description and Conflicts

From the beginning point at the F and B connection, Segment C travels approximately 10 miles west to the intersection of FM 1129 and FM 636. The majority of this route crosses open rural land, with several minor road crossings and a crossing of a residential area, the Colina Vista subdivision on Colina Vista Road east of FM 1129. The Colina Vista Subdivision tracts are approximately 10 acres each, and the route does not require the removal of any houses. The route crosses the existing 90-inch RC pipeline where a cross-connection is proposed. There are two alternate booster pump station sites located in this area, Site A located near the intersection of FM 1129 and FM 636 and Site B just west of the RC cross-connection new FM 1603. These two sites are discussed further in Section 3.

Two additional residential areas are crossed before the route reaches I-45. The first is at the crossing of FM 1603 approximately half a mile to the west of BPS 1 of 2 B. This residential area is composed of approximately 10 acre tracts, with homes on these tracts generally abutting the roadway. The route crosses perpendicular to FM 1603 through an undeveloped tract, then continues west across the backs of the parcels.

The second residential area is the Double R subdivision outside of Rice situated just east of I-45. This subdivision consists of approximately 5 acre tracts. At the time of this route study, little housing construction has occurred in this area. This subdivision was identified as a conflict area, and a route analysis comparing three routes was performed. This route analysis is included in Appendix J as C2a-Rice. None of the conflict options require the demolition of houses but they all sever some of the properties in the subdivision. The southern option was chosen for the route due to reduced severed lengths, cost benefits, and environmental advantages.

From the west side of I-45, the route continues traveling west through mostly crop and pasture land to the south end of Bardwell Reservoir. The main pipeline does not route through USACE property which was one of the significant advantages of Corridor 7b over other corridor options which had environmental and USACE conflicts on the north side of Bardwell Lake.

From the future Bardwell outlet, the route turns northwest and crosses the BNSF Railroad. The route continues for approximately 12 miles through rural crop and pasture land to the future Lake Waxahachie outlet. Going south of Lake Waxahachie helps avoid environmental and urban conflicts that are on the north side of the lake.

On the west side of the lake, the pipeline crosses the UP Railroad, US Highway 77, and I-35E which are all adjacent to each other. One mile further west is where Corridor 7a and 7b diverge. The recommended route follows Corridor 7b which avoids high points in Midlothian reducing pumping costs and eliminating the need for a Midlothian deep tunnel. Near the point where 7a and 7b converge back together at US Highway 67 the original 7b route crossed a pond. A

conflict analysis was done for this area comparing two routes. The conflict is included in appendix J as C8a-ToysRUs. The eastern option was chosen as it was less expensive and avoided the pond.

After crossing US Highway 67, the route bears northwest approximately 6.5 miles through rural property before tying into Segments G and D. Directly to the southeast of the G connection, Segment C parallels US Highway 287. State Highway 360 currently ties into US Highway 287 along this paralleling portion. In the future, State Highway 360 will likely be extended to the south, crossing both US Highway 287 and the IPL route. This should be investigated further in the conceptual design to determine if the pipe under the future SH 360 should be encased or deepened.

Table 2.9 shows the conflict analysis areas that were studied for Corridor 7b on Segment C. The complete conflict analysis for Segment C can be reviewed in Appendix J.

Table 2-9. Segment C Conflicts

Conflict Name	ID Number	Decision
Rice	C2a	South option was chosen for severance, environmental and cost benefits.
Toys R Us	C8a	Eastern option was chosen as it missed the pond conflict and presented cost savings.
New Southern Option	C11	The corridor 7b was chosen due to reduced urban impact and reduced pumping costs by routing around Midlothian Hill.

2.3.3 Hydraulics

Segment C is planned to carry 150 MGD from Lake Palestine, 127 MGD from Cedar Creek Reservoir, and an additional 70 MGD from Richland-Chambers Reservoir for a total of 347 MGD. This segment will be 108 inches in diameter. Segment D of the IPL will be downsized to 84 inches in diameter as Dallas water is delivered through Segment G.

One of the primary reasons the 7b route was preferred over others was for reduced pumping costs due to lower static heads. Other routes (1a/5, 1b/5, 1b/6, 7a) were considered which passed through higher elevations near Midlothian. See Conflict C11 in Appendix J. The alternate options either require increased pumping costs or deep tunneling options. A life cycle cost analysis performed on the routes showed that there are life cycle cost savings in reducing the high point in the pipeline to elevation 790 feet MSL. The Corridor 7b re-route reduced the high point from elevation 850 to elevation 790 and was found to be more cost effective than tunneling through these high points with other route options.

2.3.4 Crossings

Tunnel crossings in Segment C include 2 interstate highways, 1 state highway, 2 US highways, 14 FM roads, and 4 railroads. There is also a rail track that is not a mainline railroad near the Toys R Us conflict. **Table 2-10** summarizes which major roads will be crossed utilizing tunneling.

Table 2-10. Tunneled Crossings

Major Highways	FM Highways	Railroad / River Crossings
I 35 E	1129	Southern Pacific Railroad
I 45	1446	BNSF Railroad (near SH 34)
SH 34	1493	UP Railroad
US Highway 67	1603	BNSF Railroad (near US 67)
US Highway 77	636	Branch Line at Business Park
	66	
	875	
	876	
	977	
	984 (Crosses four times)	
	985	

Segment C will also include approximately 24 oil and gas crossings and 8 electrical transmission line crossings. These crossings are anticipated to be open cut.

2.3.5 Environmental

Table 2-11 summarizes environmental conflicts along segment C.

Table 2-11. Segment C Environmental Conflicts

	Number	Length, ft	Area, acre
Perennial Creek Crossings	5	970	
Intermittent Creek Crossings	113	21,402	
Wetlands			6
Upland Forest			109
Bottomland Forest			28

2.4 Segment D

2.4.1 Overview

Segment D continues from C at the connection point of G and ends at the Benbrook Pipeline tie-in located less than one mile east of the existing Benbrook outlet. The intersection of segments C, D and G is near the intersection of US Highway 287 and the US Highway 287 Business route which is southeast of Mansfield. See **Figure 2-7** for a depiction of the entire segment.

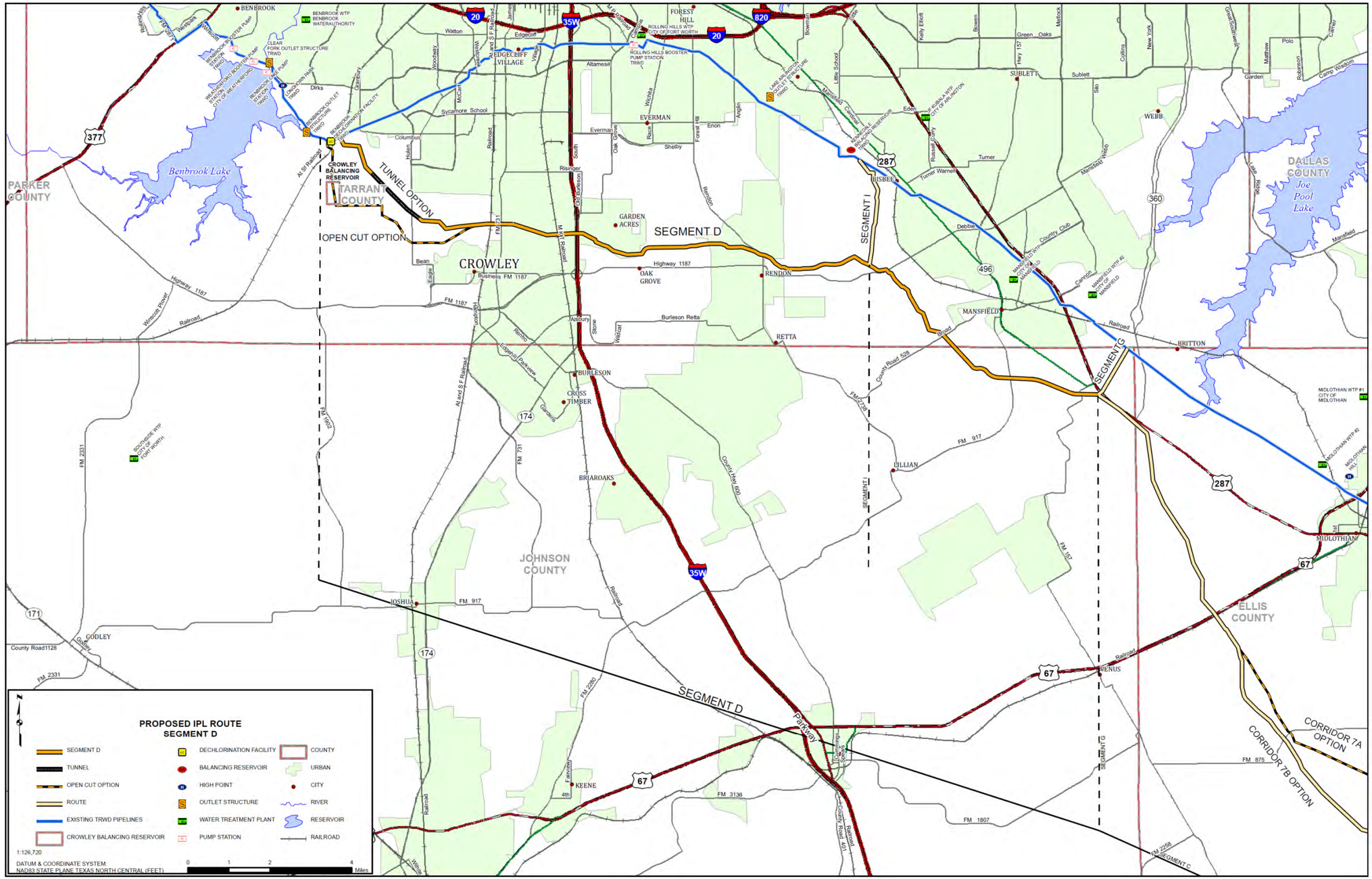

Figure 2-7. Segment D

The total length of segment D is 21.6 miles accounting for 15% of the entire mainline of the IPL route. Over 80% of the segment is composed of rural land. Currently the only deep tunnel on the IPL route is located near the end of segment D near Crowley. **Table 2-12** summarizes the breakdown of this segment:

Table 2-12. Segment D Classification

	Major Classification	Length (LF)	Detailed Classification	Length (LF)
Open Cut	Crossings	1,137	Minor Road	924
			Water	213
	Rural	93,032	Pasture	56,708
			Cropland	14,139
			Wooded	22,185
	Urban	10,412	Light Urban	10,197
			Medium Urban	215
			Heavy Urban	0
Tunnel	Crossing Tunnel	1,070	Railroad	189
			River	0
			Major Road	881
	Deep Tunnel	8,480	Deep Tunnel	8,480
Total Length - Segment D				**114,131**

With a two booster pump operation and a deep tunnel at Crowley, there are no facility sites situated along this segment. However, if the tunnel option through Crowley is found unfeasible, an open cut option with the Crowley Balancing Reservoir may be considered. The Crowley Balancing Reservoir is discussed as an option in segment 3 of this report. There are three segment D connections:

- The Segment G Connection, which is discussed separately, is currently planned to divert 150 MGD to a Dallas delivery point.
- The Segment I (KBR) Connection which is discussed separately connects to D near the US Highway 1187 crossing. Segment I is 84 inch in diameter to carry 197 MGD to the Kennedale Balancing Reservoir.
- Currently, the IPL terminates at the connection to TRWD's existing 90" Benbrook Pipeline. The Benbrook Pipeline was built in the mid 1990's and is prestressed concrete cylinder pipe (PCCP) through the open cut sections and steel pipe through the tunnel segment. The Benbrook Tunnel begins on the west side of Granbury Road, on USACE property. Connecting west of Granbury Road near the existing TRWD dechlorination facility in the open cut section is simplest from a construction standpoint. However, such a connection requires a USACE easement which entails an environmental analysis and mitigation. To reduce impact to USACE property, the connection is currently planned to be on the east side of Old Granbury Road as shown in **Figure 2-8**. This is in the tunneled portion which is approximately 30 feet deep. Thus, the connection will be in a deep trench and the casing will need to be removed from around the existing pipe. Connecting

to the east is less desirable for construction, but more desirable from a schedule and property standpoint as permitting and mitigation is avoided.

2.4.2 Route Description and Conflicts

From its beginning at the Segment G connection, the Segment D pipeline routes northwest approximately seven miles to the point where Segment I connects to the main pipeline. Just southeast of the Segment I intersection is conflict area D1-Mansfield. See Appendix J for conflict analysis D1-Mansfield and D1a-Mansfield. Upon evaluation of the conflict area, the northeastern route option was chosen. The northeastern option is more rural than the other options bypassing several well pads to the east of an electrical transmission line and crossing FM 1187 before the Segment I connection. The northeastern option was chosen due to reduced environmental impacts, cost advantages and the fact that it missed a new mining operation and several structures. All other options required the demolition of several small homes.

After the Segment I connection, Segment D turns from bearing northwesterly to bearing westerly. Approximately 3 miles west of the Segment I connection, the route passes through another conflict area. See Appendix J for conflict analysis D2-Rendon. Four routes were considered for routing through the urban Rendon congestion. All routes considered require the demolition of houses. The selected route is the northern most which requires the demolition of a single house while the other routes required the demolition of 3, 4, and 5 houses. The house on the chosen route lays just to the east of the intersection of Rendon Road and Valley Ridge road.

The Segment D route continues west to conflict D3-I35; see Appendix J for the conflict analysis. The northern option which routes north of Crowley Middle School at FM 731 was chosen for the route by TRWD on February 10, 2010. Although this was not the least expensive route, it was most favorable due to avoiding urban conflicts and conflicts with the middle school.

West of I-35W, two routes were studied to connect to the Benbrook Pipeline. The first route is an open cut option that winds through several subdivisions to a high point west of Crowley and a site of a potential terminal storage reservoir. The reservoir would have several operational benefits, but adds power cost at low flow rates. From the reservoir, the pipeline bears in a northerly direction and tunnels under a railroad and Old Granbury Road to connect to the Benbrook Pipeline on USACE property.

A second route, called the 790 Tunnel Option, takes a more direct route to the proposed Benbrook connection point and tunnels at elevation 790’ MSL under the high ridge passing through Crowley. Although the tunnel option is more expensive in capital costs, life cycle costs show a breakeven point after 100 years. In addition, the tunnel route will have less impact on the environment, less impact on the community and should require less maintenance. The 790 Tunnel Option was chosen by TRWD as the preferred route. **Figure 2-9** shows the two alignments studied through the Crowley area and the portion of the pipeline to be installed in a tunnel.

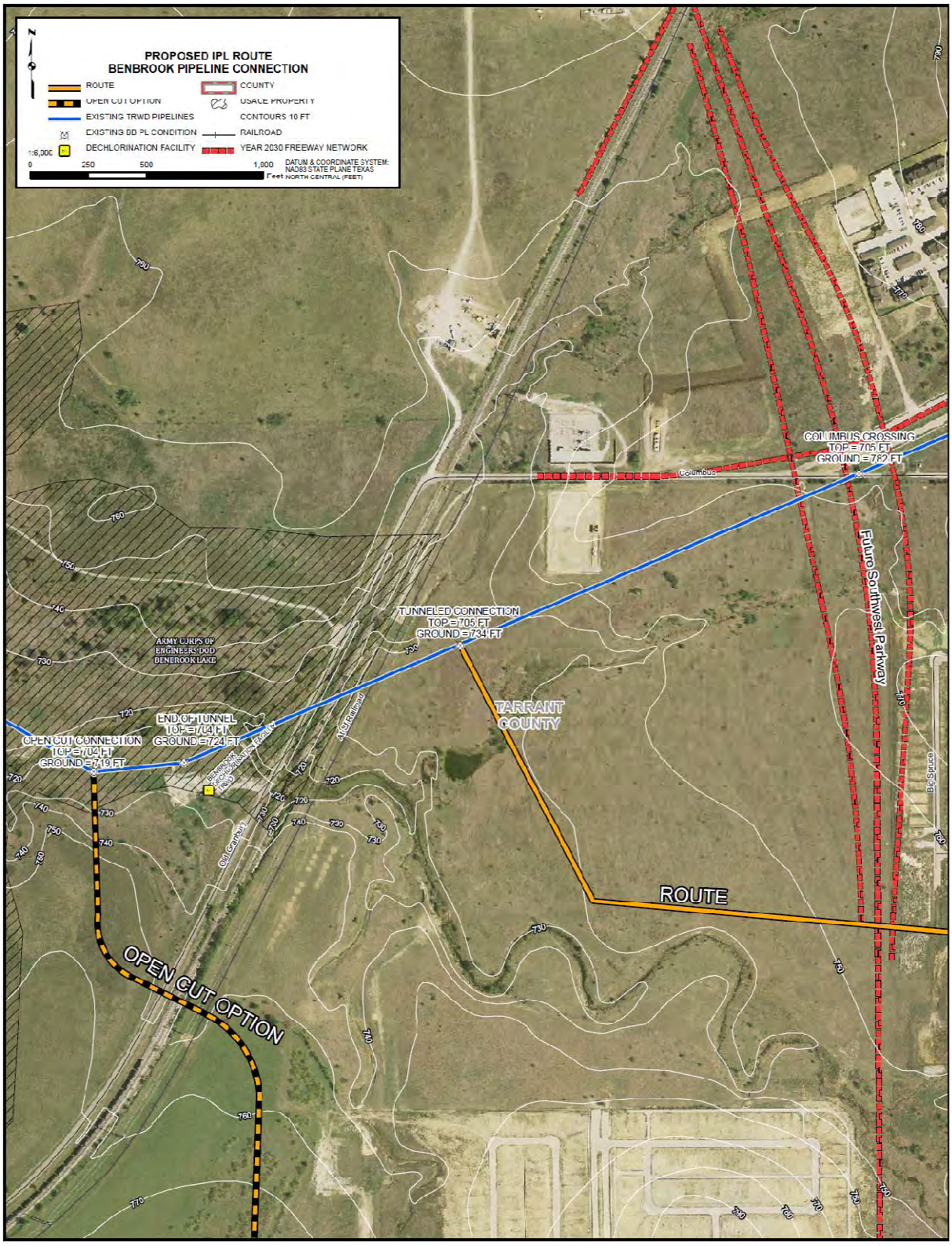

Figure 2-8. Benbrook Connection

The chosen 790 Tunnel Option extends from the northern D3-I35 option to a point southeast of Crowley High School. At this point the tunnel passes under the High School property to an open lot lying between a subdivision and a gas facility. The length of the tunnel is 8,480 feet and is approximately 50 feet deep.

From the end of the tunnel the route bears northerly along a subdivision before turning west for the proposed crossing of the future Southwest Parkway. Soon after the proposed Southwest Parkway crossing, the route ties into the existing Benbrook waterline on the east side of Old Granbury road. This portion of the Benbrook line was tunneled which will require a deep connection point. However, by connecting to the east of Old Granbury road instead of the west, USACE property can be avoided.

Table 2-13 shows the conflict analysis areas that were studied for Segment D. The complete conflict analysis' can be reviewed in Appendix J.

Table 2-13. Segment D Conflicts

Conflict Name	ID Number	Decision
Mansfield	D1	Moved to the east of the power-line easement to miss two houses and the new mining operations.
Rendon	D2	Re-routed north to miss two houses.
I35	D3	North route to avoid school and urban conflicts.

2.4.3 Hydraulics

As described above, pumping costs are reduced by utilizing a deep tunnel through the ridge near Crowley. This lowers the high point of the line by approximately 50 feet. An alternative to this is an open cut route to the south of Crowley High school and a balancing reservoir. While the open cut alternative would present lower construction costs, the tunnel was chosen to reduce long term pumping and maintenance cost.

2.4.4 Crossings

Tunnel crossings in Segment D include an interstate highway, four FM roads, and two railroads as listed in **Table 2-14**.

Table 2-14. Tunneled Crossings

Major Highways	FM Highways	Railroad / River Crossings
I-35W	157	MKT Railroad
	917	AT & SF Railroad
	1187	
	731	

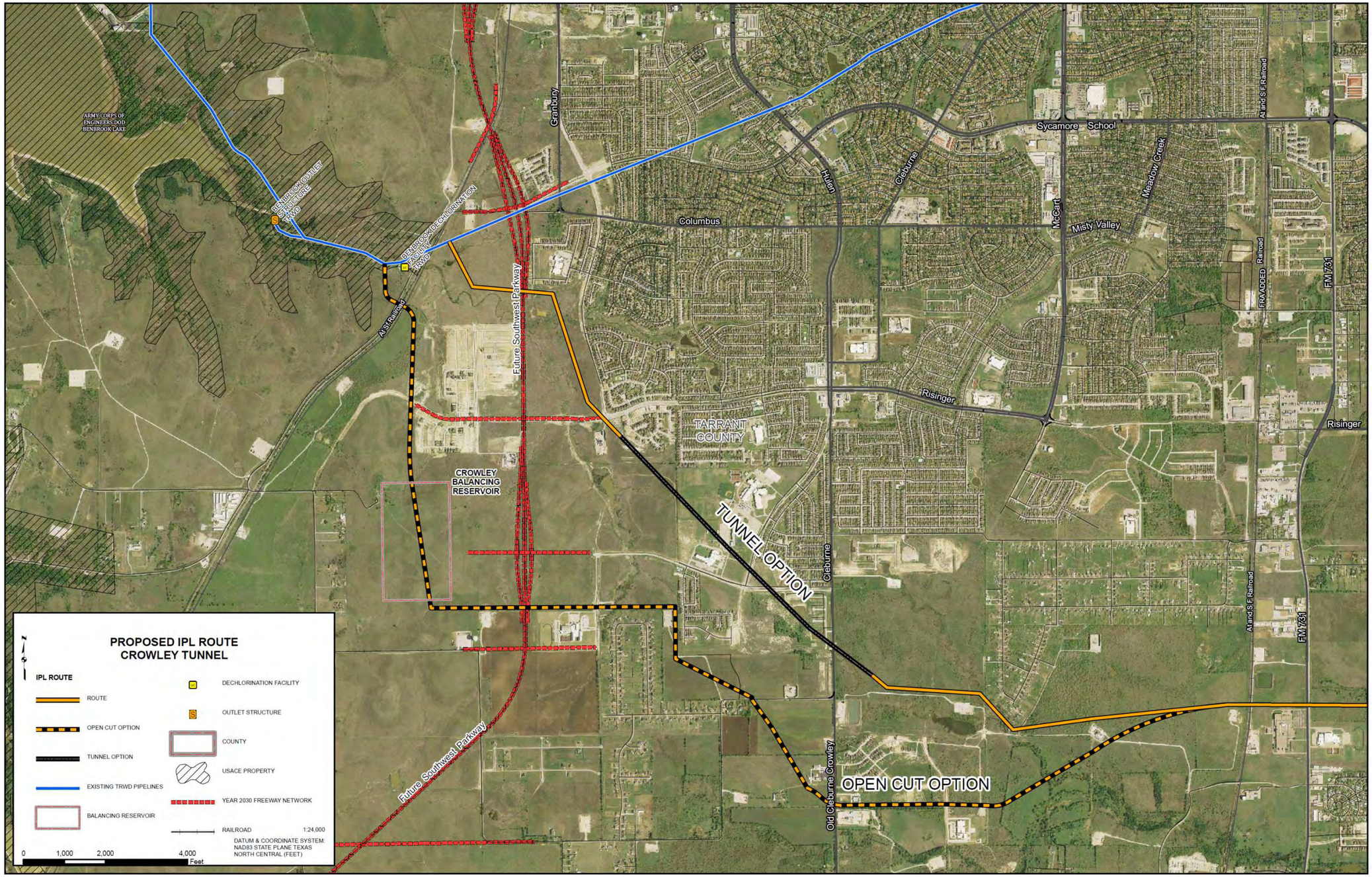

Figure 2-9. Crowley Tunnel Options and Alternate Open Cut Option

Segment D will also include approximately 34 oil and gas crossings and 17 electrical transmission line crossings. These crossings will be open cut.

2.4.5 Environmental

Table 2-15 summarizes environmental conflicts along segment D.

Table 2-15. Segment D Environmental Conflicts

	Number	Length, ft	Area, acre
Perennial Creek Crossings	3	536	
Intermittent Creek Crossings	24	5,272	
Wetlands			2
Upland Forest			6
Bottomland Forest			65

2.5 Segment E – Cedar Creek to Integrated Pipeline

2.5.1 Overview

Segment E begins at the proposed Cedar Creek Reservoir Pump Station at the southwest corner of Cedar Creek Reservoir. Segment E proceeds southwest from the proposed pump station and connects to the Integrated Pipeline at the beginning of Segment B. Segment E has a 72-inch diameter and it has a design capacity of 127 MGD. Refer to **Figure 2-4** for a map featuring Segment E.

Table 2-16 is a summary of the Segment E route construction classification. As seen in the table, Segment E is mainly comprised of rural land with 98% of the route being either pasture or wooded areas. Nearly ninety percent of the segment passes through rural prairies, and the remaining ten percent passes through densely wooded areas.

Table 2-16. Segment E Route Classification

	Major Classification	Length (LF)	Detailed Classification	Length (LF)
Open Cut	Crossings	29	Minor Road	29
			Water Body	-
	Rural	8,370	Pasture	-
			Cropland	7,557
			Wooded	813
	Urban	-	Light Urban	-
			Medium Urban	-
			Heavy Urban	-
Tunnel	Crossing Tunnel	118	Railroad	-
			River	-
			Major Road	118
	Deep Tunnel	-	Hydraulic Advantage	-
Total Length – Segment E				**8,517**

The only facility located within the Segment E route is the Cedar Creek Reservoir Intake Pump Station at the beginning of the route. A description of the proposed Cedar Creek Reservoir Pump Station is included in Section 3.

2.5.2 Route Description and Conflict Analysis

Segment E has a length of 8,517 feet, and a few bends. One bend is to miss a cemetery and the other to avoid businesses and residences along State Highway 274. The pipeline will pass through the Cedar Creek Reservoir dam embankment which will require a special design with review and approval by TCEQ. This design could require an aerial crossing but a more typical design would be a concrete encased section of pipe through the embankment with select backfill. Tunneling will also be required for the crossing of State Highway 274.

2.5.3 Environmental

For a detailed analysis of creek crossings see the environmental report in Appendix C. **Table 2-17** is a summary of the environmental areas crossed by Segment E.

Table 2-17. Segment E Environmental Conflicts

	Number	Length, ft	Area, acre
Perennial Creek Crossings	-	-	
Intermittent Creek Crossings	1	196	
Wetlands			1
Upland Forest			1
Bottomland Forest			0

2.6 Segment F

2.6.1 Overview

Segment F begins at the existing Richland-Chambers Reservoir Pump Station on the north shore of Richland-Chambers Reservoir as shown in **Figure 2-4**. The end point of Segment F is approximately 11 miles north at the end of Segment B and the beginning of Segment C. Segment F generally runs north from the Richland-Chambers Reservoir Pump Station to the east side of Kerens and continues north to the connection point with Segments B and C. **Table 2-18** summarizes the breakdown of this segment:

Table 2-18. Segment F Route Classification

	Major Classification	Length (LF)	Detailed Classification	Length (LF)
Open Cut	Crossings	552	Minor Road	400
			Water	152
	Rural	56,727	Pasture	36,358
			Cropland	5,803
			Wooded	14,566
	Urban	0	Light Urban	0
			Medium Urban	0
			Heavy Urban	0
Tunnel	Crossing Tunnel	489	Railroad	120
			River	0
			Major Road	369
	Deep Tunnel	0	Deep Tunnel	0
Total Length – Segment F				**57,768**

Segment F is proposed to carry 70 MGD from Richland Chambers Reservoir. This segment will be 66-inches in diameter.

2.6.2 Route Description and Conflicts

The route parallels the existing 90-inch Richland Chambers pipeline for the first 3,600 feet then travels north toward Kerens. The route travels across rural areas to State Highway 309, parallels the west right-of-way of SH 309 for 700 feet, crosses Highway 309, and then parallels the east right-of-way line for 4,400 feet. This jog across the road helps decrease wooded area crossing on the west side of SH 309. The route continues north across mostly open rural land to the crossing of the St. Louis Southwestern Railroad and State Highway 31 approximately 1.6 miles east of Kerens. North of the highway, the route continues to the connection with Segments B and C through mostly open pasture land.

No conflict analysis areas were required during the Segment F route selection.

2.6.3 Crossings

Tunnel crossings in Segment F include 2 state highways, 1 FM road, and 1 railroad. **Table 2-19** summarizes which major roads will be crossed utilizing tunneling.

Table 2-19. Tunneled Crossings

Major Highways	FM Highways	Railroad / River Crossings
SH 309	3096	St. Louis Southwestern
SH 31		

Segment F will also include approximately 3 oil and gas crossings and 3electrical transmission line crossings. These crossings are anticipated to be open cut.

2.6.4 Environmental

Table 2-20 summarizes environmental conflicts along Segment F.

Table 2-20. Environmental Conflicts

	Number	Length, ft	Area, acre
Perennial Creek Crossings	2	409	
Intermittent Creek Crossings	10	2,150	
Wetlands			3
Upland Forest			15
Bottomland Forest			5

2.7 Segment G

2.7.1 Segment G Overview

Segment G begins near the intersection of US Highway 287 and State Highway 360 where pipeline Segments C and D intersect as shown in **Figure 2-10**. The end point of Segment G is at the connection to the existing Richland-Chambers pipeline, approximately 1.4 miles to the north. Segment G generally runs north from Segments C and D to the connection point across open rural land. **Table 2-21** summarizes the breakdown of this segment:

Table 2-21. Segment G Route Classification

	Major Classification	Length (LF)	Detailed Classification	Length (LF)
Open Cut	Crossings	27	Minor Road	27
			Water	0
	Rural	6,759	Pasture	172
			Cropland	5,989
			Wooded	598
	Urban	0	Light Urban	0
			Medium Urban	0
			Heavy Urban	0
Tunnel	Crossing Tunnel	334	Railroad	0
			River	0
			Major Road	334
	Deep Tunnel	0	Deep Tunnel	0
Total Length – Segment G				**7,120**

2.7.2 Route Description and Conflicts

Three routes were studied for segment G all of which traveled roughly 1.5 miles northerly to the existing RC-pipeline. See Appendix J for the conflict analysis comparing the three options. The western option, which was chosen due to shorter length and reduced cost, travels north from the beginning point at Segments C and D across an open field to the connection point with the existing Richland-Chambers pipeline.

2.7.3 Hydraulics

Segment G is proposed to carry 347 MGD from the IPL to the Richland-Chambers pipeline. This segment will be 108-inches in diameter. This will allow Dallas to deliver 150 MGD to Joe Pool Lake or to Bachman WTP through Segment H. With Segment I, TRWD does not need the ability to deliver 197 MGD through Segment G; however, the added flexibility and redundancy may justify keeping Segment G in the IPL

2.7.4 Crossings

Tunnel crossings in Segment G include 1 US highway. **Table 2-22** summarizes which major roads will be crossed utilizing tunneling.

Table 2-22. Tunneled Crossing

Major Highways	FM Highways	Railroad / River Crossings
US Highway 287	----	----

Segment G will also include approximately 1 oil and gas crossings with no major electrical transmission line crossings. The crossing is anticipated to be open cut.

2.7.5 Environmental

Table 2-23 summarizes environmental conflicts along Segment G.

Table 2-23. Environmental Conflicts

	Number	Length, ft	Area, acre
Perennial Creek Crossings	-		
Intermittent Creek Crossings	2	339	
Wetlands			-
Upland Forest			2
Bottomland Forest			1

2.8 Segment I

2.8.1 Overview

Segment I, also called the KBR connection, branches from Segment D near the crossing of FM 1187. After traveling north approximately three miles through rural pasture and light urban conflicts, the route will join TRWD's existing pipeline. From this point, the Kennedale Balancing Reservoir is located 1,000 feet to the northwest. It has not been determined if the pipeline can connect to the existing pipelines at this location, or if the pipeline will need to be extended to the KBR, paralleling the existing TRWD pipelines. See **Figure 2-10** for the route location. **Table 2-24** summarizes the breakdown of this segment.

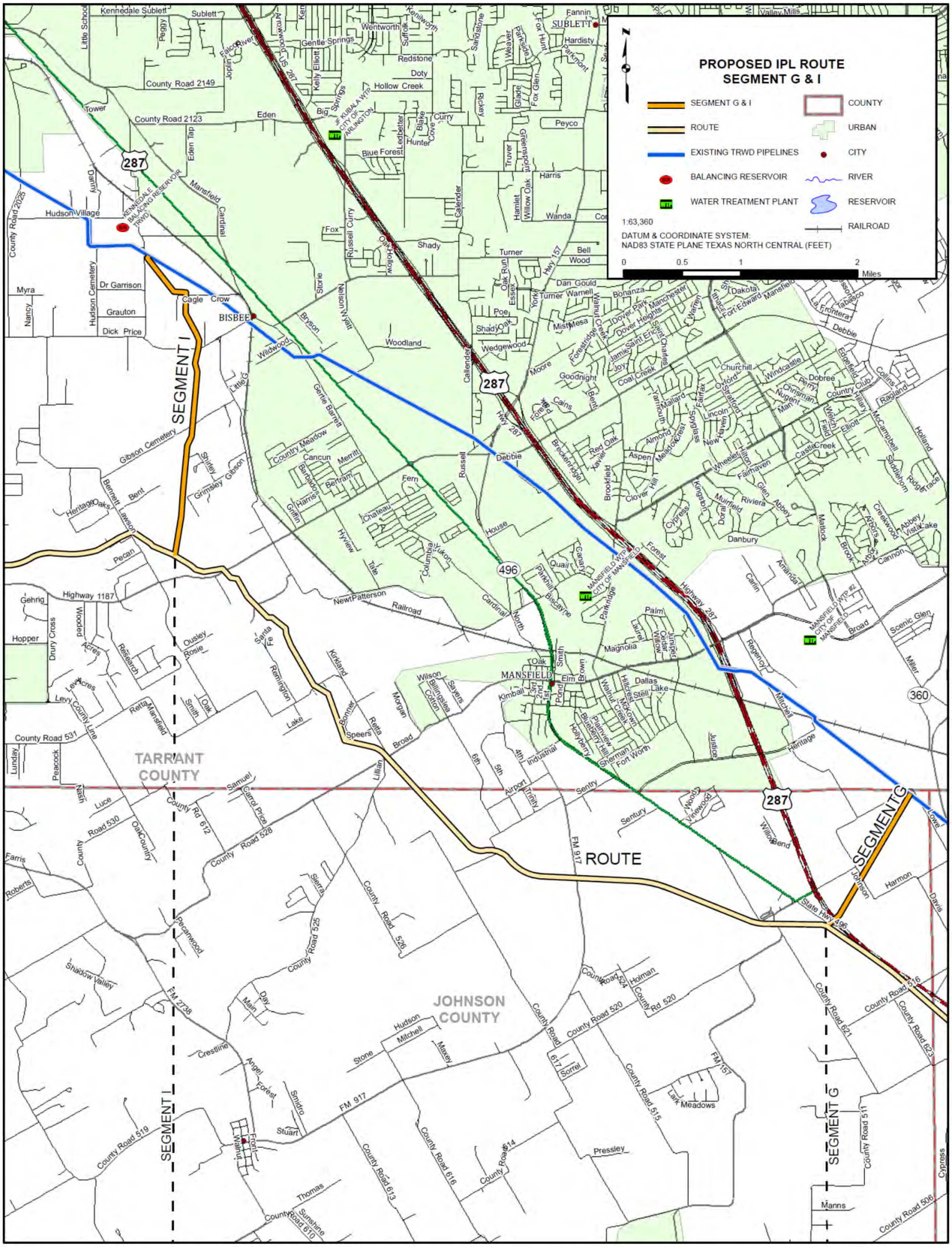

Figure 2-10. **Segments G & I**

Table 2-24. Segment I Classification

	Major Classification	Length (LF)	Detailed Classification	Length (LF)
Open Cut	Crossings	178	Minor Road	178
			Water	0
	Rural	13,105	Pasture	8,922
			Cropland	0
			Wooded	4,183
	Urban	1,482	Light Urban	1,482
			Medium Urban	0
			Heavy Urban	0
Tunnel	Crossing Tunnel	0	Railroad	0
			River	0
			Major Road	0
	Deep Tunnel	0	Hydraulic Advantage	0
Total Length – Segment I				**14,765**

2.8.2 Route Description and Conflicts

A field visit on March 25, 2010 confirmed that several possible routes paralleling a gas line are not feasible. Thus, a portion of the route was shifted approximately 1,000 feet to the east of the originally conceived route. The route now bears north until crossing Dick Price Road. At Dick Price the route turns to the northwest gradually drawing closer to the existing waterline.

2.8.3 Hydraulics

The purpose of this segment is to provide a cross connection to the existing East Texas System. The cross-connection provides the ability to increase the delivery rate to KBR without having to parallel the existing 90-inch and 72-inch pipelines through the urban Mansfield area. In turn, this will increase reliability and will give TRWD multiple options in managing water within their existing network.

2.8.4 Crossings

There are no major road or railroad crossings within segment I. The route crosses several minor roads which are anticipated to be open cut. From south to north the roads are:

- Gibson Cemetery Road
- Dick Price Road
- Cagle Crow Road

The pipeline also crosses several driveways, approximately four oil and gas lines and one electrical transmission line.

2.8.5 Environmental

Table 2-25 summarizes environmental conflict along segment I.

Table 2-25. Segment F Environmental Conflicts

	Number	Length, ft	Area, acre
Perennial Creek Crossings	1	175	
Intermittent Creek Crossings	1	28	
Wetlands			1
Upland Forest			8
Bottomland Forest			1

2.9 Next Steps

With the conclusion of this route selection, the pipeline effort will transition from a desktop route study to a final surveyed alignment which will be used in the final design of all segments.

To date, the corridor and route studies have been primarily "desktop" studies using aerial photography, available records and databases, and readily available property data. In order to refine the route to the final alignment, significant field work will be required. In general, the following tasks will be performed in the conceptual design phase:

- Surveyors will research all boundary information for affected and potentially affected properties and provide a database of the landowner and property information.
- Landowner right of entry permission will be obtained on all properties the route crosses as well as adjoining properties. Permission to access adjoining properties may be needed in order to help facilitate minor re-routes around conflicts that are discovered in the field.
- Engineering, environmental, and archeological teams will walk the entire route and identify conflicts in the field. These conflicts will be analyzed and the alignment will be modified to avoid or mitigate the impacts. Subsurface Utility Engineering (SUE) will be required to locate existing utilities.
- Surveyors will establish project control for aerial photography and land survey, and provide photography and topographic survey.
- Once the alignment is established, easement documents will be provided to TRWD and Dallas for acquisition.

At the end of the conceptual design phase, the centerline of the proposed IPL will be established, along with corresponding 150 foot-wide right of way. This alignment will be used for the final design effort and environmental permitting.

Section 3
Facility Sites

This section of the report describes the proposed facilities for the Integrated Pipeline Project. The following table lists the facilities discussed in this section of the report.

Table 3-1. Summary of Facility Sites

Lake Palestine Pump Station	Anderson	150 MGD	Initial (pending Dallas decision)
Cedar Creek Lake Pump Station	Henderson	127 MGD / 190 Peak	Initial
Richland-Chambers Lake Pump Station	Navarro	70 MGD Initial / 250 MGD Future	Initial
Booster Pump Station 1 of 2	Navarro	350 MGD	Initial
Booster Pump Station 2 of 2	Ellis	350 MGD	Initial
Crowley Balancing Reservoir	Tarrant	200 MG Initial / 400 MG future	Delayed or Deleted with Crowley Tunnel

The timing of construction for all pump stations is contingent on the final phasing analysis to be completed in the conceptual design phase of this project. Timing of construction for the Lake Palestine Pump Station is contingent on Dallas' decisions as to the timing of their need for additional supplies. The Crowley Balancing Reservoir was proposed during the corridor selection phase of the project. The conclusion from recent studies is to build a tunnel through high ground in the Crowley area, thus possibly eliminating the need for the balancing reservoir. Because the decision as to building this tunnel will be refined in the Conceptual Design Phase, the description and site study for the balancing reservoir has been included in this report.

3.1 Lake Pump Stations

This section describes the three lake pump stations at Lake Palestine, Cedar Creek Reservoir and Richland-Chambers Reservoir. The lake pump station sites are well established based on previous studies. For lake pump stations, the optimum site would be on a steep bank on the lake shore that provides close access to deep water and high ground out of the flood pool. The site would also have good foundation soils. The optimum site would also be near public road access and close to high voltage power.

3.1.1 Lake Palestine Pump Station

The Integrated Pipeline begins at a proposed intake pump station site on the west side of Lake Palestine. The recommended location is approximately one mile north of the Blackburn Dam and was selected as part of the *Lake Palestine Utilization and Pipeline Alignment Study, June 1989*. The recommended property was purchased by Dallas based on the conclusions of that report. A location map of the Lake Palestine Pump Station is illustrated in **Figure 3-1**.

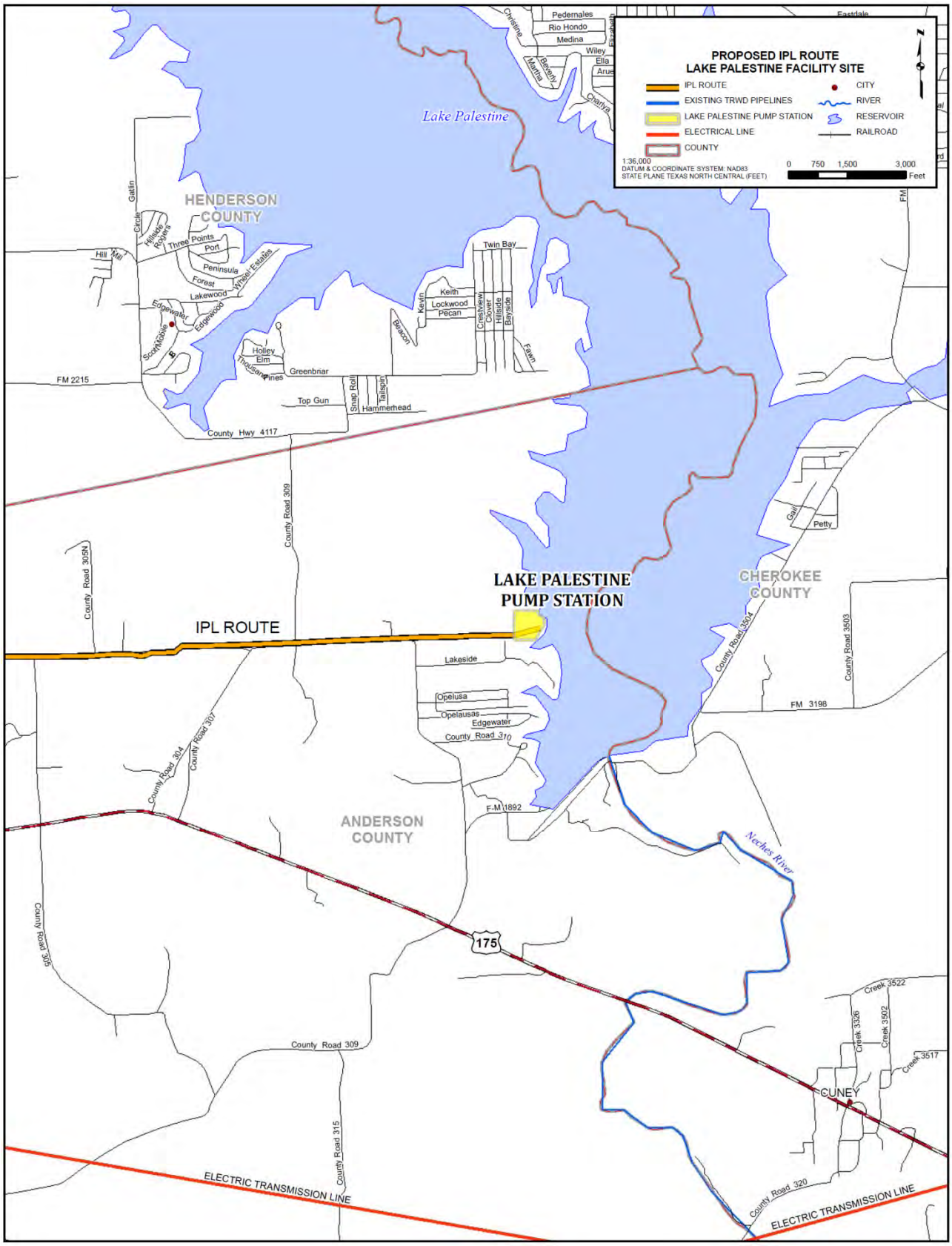

Figure 3-1. Lake Palestine Location Map

The selected site is adjacent to deep lake water, has good foundation soils, access to power, and has sufficient space to allow flexibility in the intake design. Deeper water at the pump station site will increase reliability. Other sites were explored to verify that the previously recommended site was the most preferred and this study recommends the same site.

Figure 3-1 shows that the pump station is located 1.5 miles north of U.S. Highway 175. Access to the pump station is off County Road 309, an existing two-lane asphalt road. It is anticipated that a new 3,000 foot long access road will be needed from C.R. 309 to the site. The access road would likely be constructed in the proposed pipeline easement.

The site is a wooded lot that fronts the southwest side of the lake. A photograph of the site is shown in **Figure 3-2**.

Figure 3-2. Photograph of the Lake Palestine Pump Station Site

Rayburn Electric Co-op has a 138 KV transmission line approximately 1.5 miles south of the recommended site. The electric transmission line runs from the northwest to the southeast and crosses Highway 175 about 3,000 feet west of the CR 309. It is anticipated that the power line can be routed along C.R. 309 and into the site paralleling the access road and pipeline. **Figure 3-1** shows the power line in relation to roads.

Lake levels are important design criteria influencing the location and layout of an intake pump station. **Table 3-2** is a summary of key elevations for Lake Palestine, based on information from the TWDB report "Volumetric Survey of Lake Palestine, June 2003 Survey".

Table 3-2. Key Elevations for Lake Palestine

Top of Dam	364.0
Design Water Surface (Flood Conditions)	355.3
Spillway Crest (Conservation Pool)	345.0
Low Flow Outlet (Drought Conditions)	309.5

The old river channel bottom has an elevation of 300 feet. According to the area and capacity curve for Lake Palestine in the TWDB "Engineering Data" report, an intake elevation of 315 feet will access 95 percent of the lake's storage capacity. In order to pull water from an elevation of 315 feet, it is anticipated that the pump will need approximately 10' of submergence; therefore an intake channel at an approximate elevation of 300-305 feet is preferred. In order to access such a lake bottom elevation, an intake channel approximately 1,200 feet in length is needed to be dredged to reach the old river channel. **Figure 3-3** shows an aerial map of the proposed lake pump station site along with contours from the 2003 TWDB Volumetric Survey.

In 1988, a boring was taken on the pump station by McClelland Engineers and is described in their letter report dated July 25, 1988. The boring at the site shows a 1-2 foot thick layer of silty sand at the surface. Beneath this sand, a stiff to very stiff sandy clay was present to a depth of 14 feet. A sand layer three feet thick overlaying the bedrock was encountered from 14 to 17 feet. A greenish gray carboneous shale was encountered at depths of 17 feet to 32 feet. A 6 to 8 foot thick layer of porous sandstone was present from 32 feet to 38 feet. Below the sandstone is another 36' of carbonaceous shale with layers of sandstone to a depth of 74 feet where the boring was terminated. McClelland reports that water was encountered at depths of 14 to 15 feet, near the top of the sandstone layer. Shortly after encountering the water, the level rose to depths of 3 to 8 feet which was above the lake level.

The proposed site is suitable for several intake options including the following:

- A dredged intake channel with a wet-dry pit on shore that houses horizontal split-case pumps at the bottom of the pit, similar to DWU's Lake Fork Pump Station.
- A dredged intake channel to a sump pit on the shore with vertical turbine pumps set above the wet-well.
- A platform type pump station with vertical turbine pumps in the lake with a dredged channel to reduce the length of the bridge deck, similar to TRWD's Benbrook Lake Pump Station.
- A sump pit constructed on shore with intake pipes bored or tunneled into the lake with a dredged channel to the intake screens to reduce pipe length.

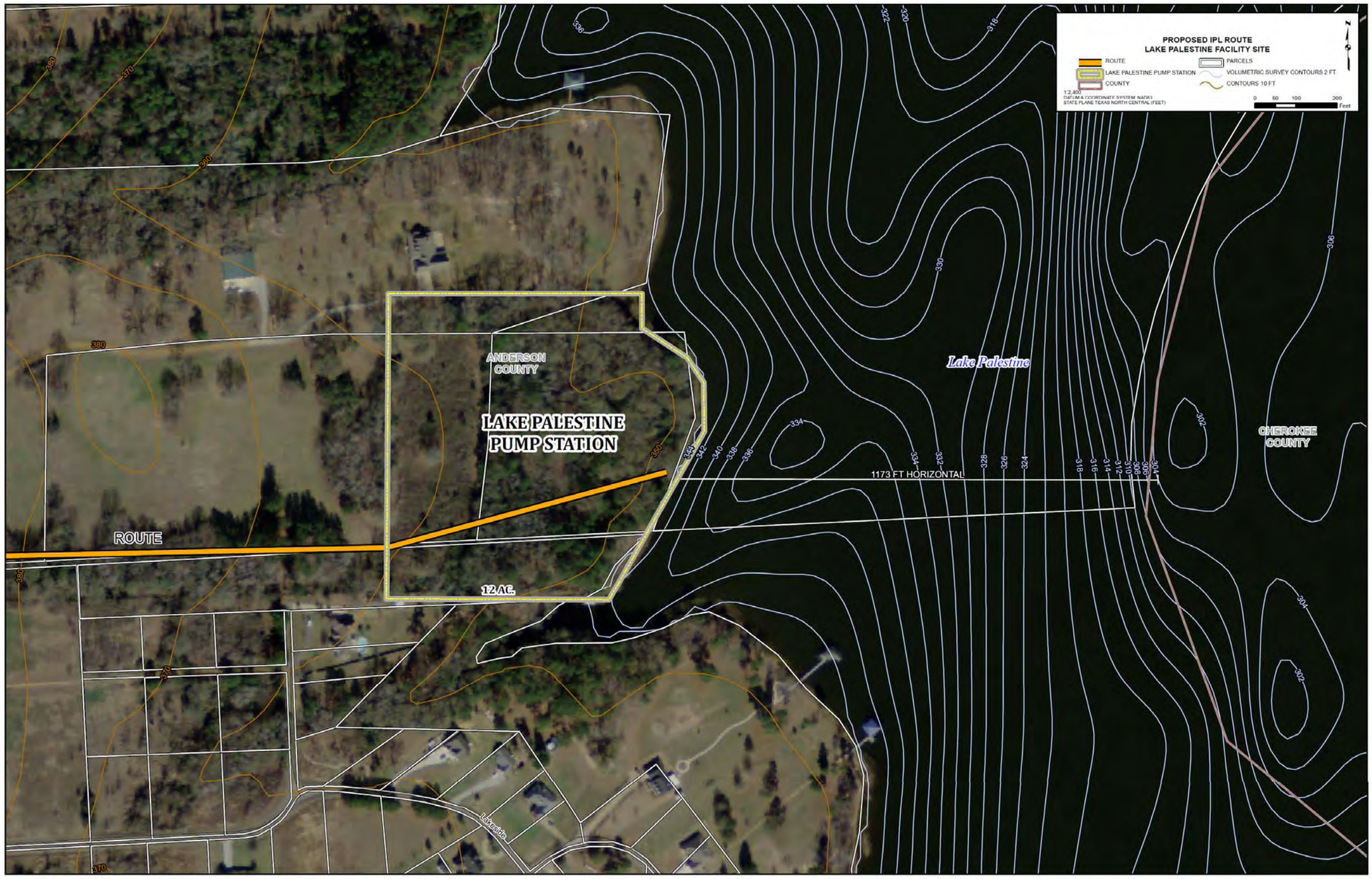

Figure 3-3. Lake Palestine Site Map

These options along with others should be evaluated in the conceptual design phase to determine the best layout in terms of capital costs, environmental impact, reliability, maintenance requirements and owner preference.

Future steps in the conceptual design phase should include geotechnical work and survey. Additional geotechnical borings are required on the site and in the lake. A topographical survey and a bathymetric survey are also recommended early in the conceptual design phase to facilitate layouts.

3.1.2 Cedar Creek Pump Station

Cedar Creek Reservoir supplies 127 MGD to the Integrated Pipeline through pipeline Segment E. Lake Pump Station sites were studied on both the east and west side of the reservoir during the corridor study. The selected pump station site is on the west side of the reservoir, approximately 1.5 miles north of the main transmission pipeline. The site is a large wooded area near the dam with adequate room for construction staging and is owned by TRWD. **Figure 3-4** shows a location map of the proposed Cedar Creek Pump station.

TXU/Oncor transmission lines are located 5,000' from the proposed pump station site. The nearby electric transmission lines provide 69 KV, 138 KV, and 345 KV and can be seen in **Figure 3-4**. State Highway 274 is located almost a mile southwest of the site. Mankin Road can be taken from SH 274 to get within half a mile of the site. Mankin Road connects to Key Ranch Road to the north and Forehand Road to the east. An access road must be constructed either from Mankin Road, Forehand Road or Key Ranch Road to access the pump station site.

Data on Cedar Creek Reservoir was obtained from the Texas Water Development Board "Report 126 - Engineering Data on Dams and Reservoirs in Texas, Part II". The TWDB "Engineering Data" shows that the lake is impounded by Joe Hogsett Dam, elevation 340.0 feet above mean sea level. The 100-year flood elevation for Cedar Creek Reservoir is 325.0 feet at the top of the spillway gates. Conservation pool level is 322.0 feet. It is recommended that the proposed pump station be located at a site with an elevation several feet above 325 feet MSL, preferably closer to 334 feet to match the flood protection of the existing TRWD pump station which is located further north along the lake shore.

The Texas Water Development Board performed a bathymetric survey in July of 2005 for the purposes of determined the volume of the reservoir. Based on the survey and volume calculations, the following distances from the site shoreline to various contours are listed along with the storage available at each elevation.

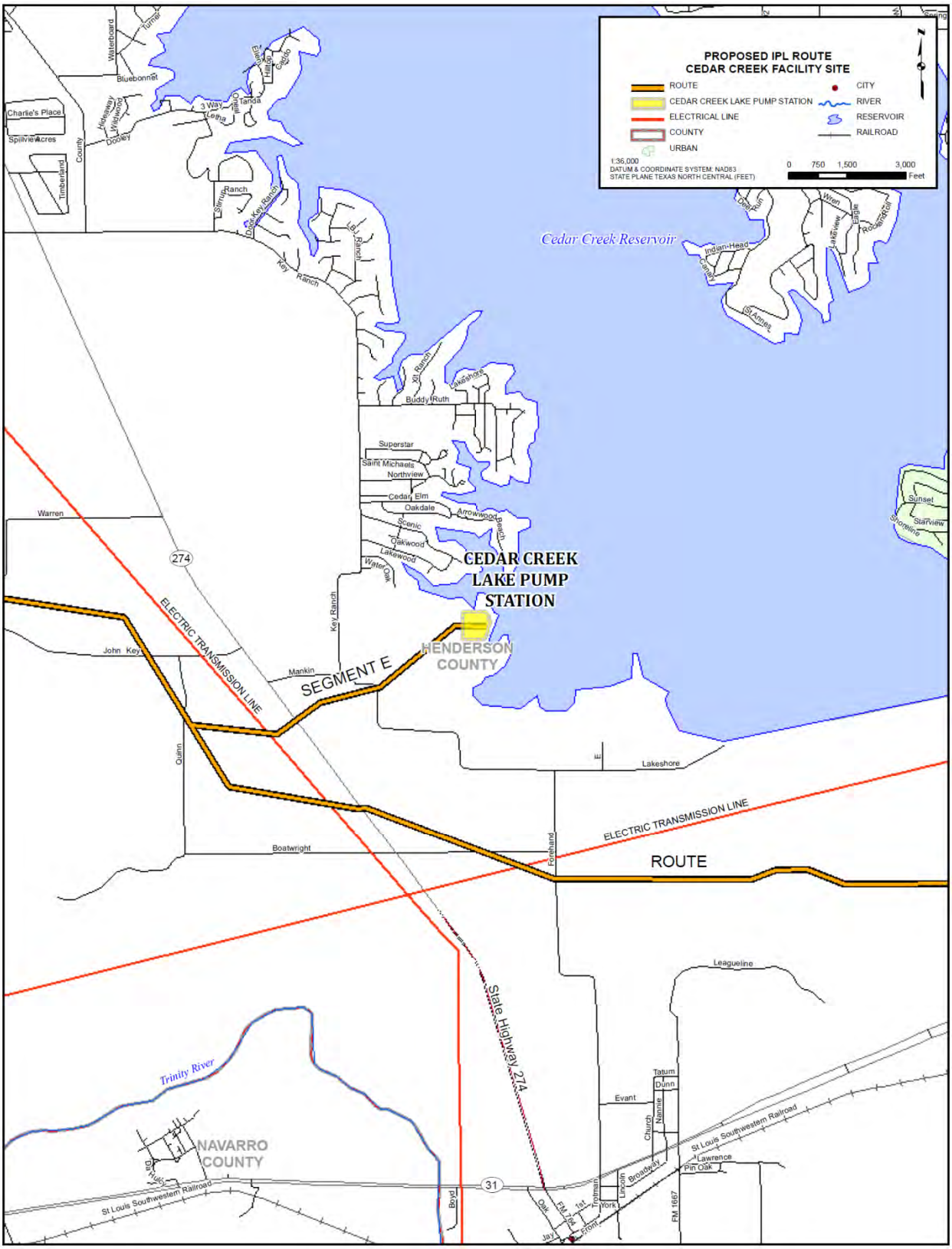

Figure 3-4. Cedar Creek Facility Site Location

Table 3-3. Cedar Creek Intake Channel Criteria

Elevation	Distance to Elevation (Feet)	Storage Capacity (ac-ft)	Percent of Storage Capacity
270	4,200’	1,264	99.80 %
275	2,200’	4,978	99.22 %
280	2,000’	14,257	97.76 %
285	1,100’	37,182	94.16 %
322	0	637,180	

According to the storage capacity table for Cedar Creek Reservoir in the TWDB April 2007 Report, an intake channel with a bottom elevation of 285 feet will access 94.2 percent of the lake’s storage capacity. An intake channel bottom elevation of 280 feet will access 97.7 percent of the lake’s storage capacity. Since the existing intake pump station can access water down to 275.0 feet, it seems access to 280.0 feet is adequate; however a deeper intake channel may be required to pump down to elevation 280.

A trapezoidal drainage channel runs east-west along the south side of the proposed pump station site. The soils excavated from this channel raised the site above the lake flood level. The preferred pump station site elevation is above the 330-foot contour line according to USGS maps of the area. Flood level for the lake is 325 feet. This proposed site is heavily wooded but is not located near any residential areas and the proposed pump station site is large enough for multiple pump station layout options. See **Figure 3-5** for site details.

Similar to the Lake Palestine site described above, the proposed Cedar Creek Lake Pump Station site is suitable for several intake options including the following:

- A dredged intake channel with a wet-dry pit on shore that houses horizontal split-case pumps at the bottom of the pit, similar to DWU’s Lake Fork Pump Station.
- A dredged intake channel to a sump pit on the shore with vertical turbine pumps set above the wet-well.
- A platform type pump station with vertical turbine pumps in the lake with a dredged channel to reduce the length of the bridge deck, similar to TRWD’s Benbrook Lake Pump Station.
- A sump pit constructed on shore with intake pipes bored or tunneled into the lake with a dredged channel to the intake screens to reduce pipe length.

It may be possible to use the trapezoidal drainage channel as part of the intake channel for the proposed pump station. The channel will need to be enlarged but may reduce the amount of dredging required to reach the proper elevation. A bathymetric survey is recommended for this site to verify lake depths as well as borings on land and in the lake.

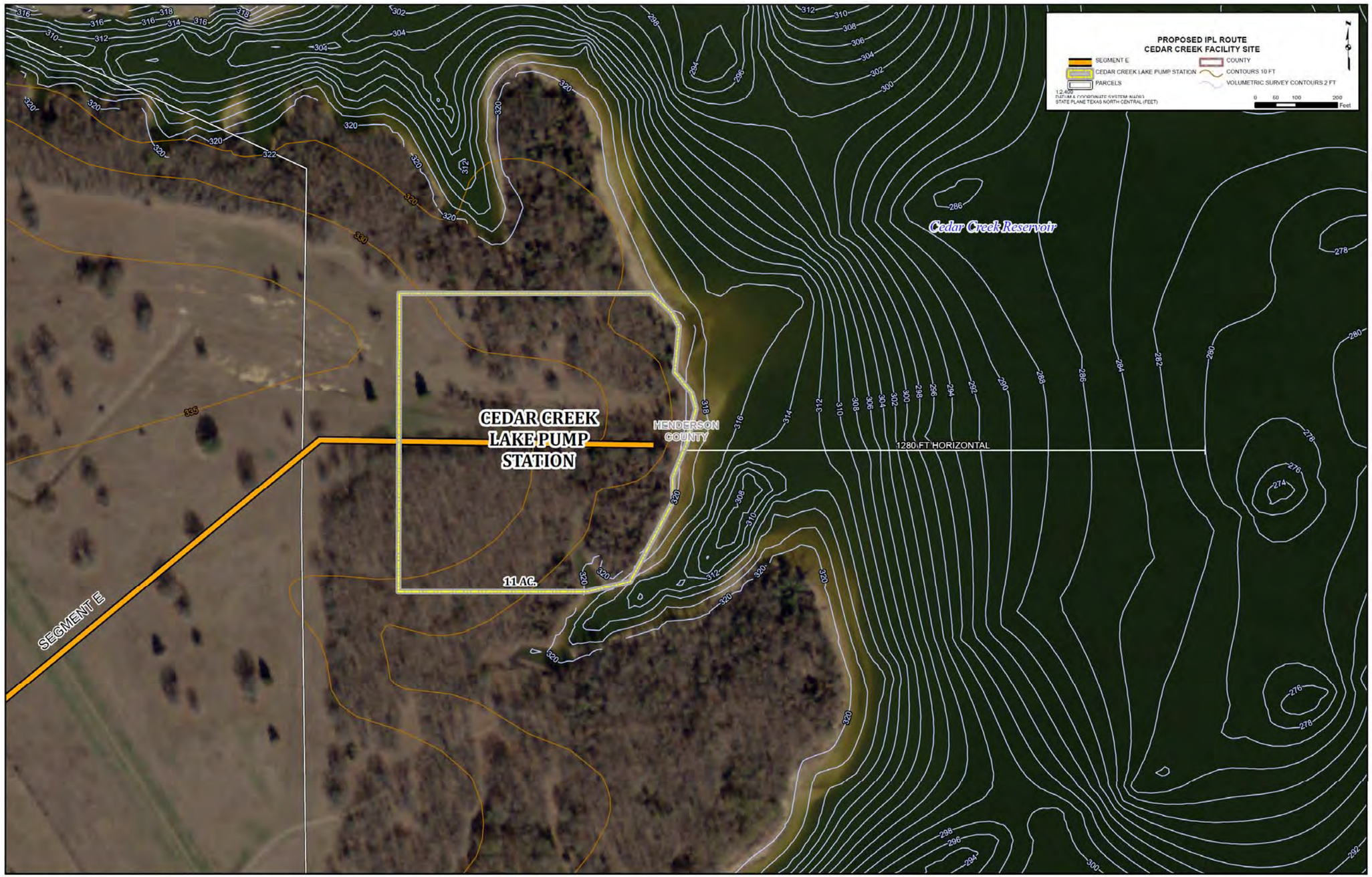

Figure 3-5. Cedar Creek Facility Site

3.1.3 Richland-Chambers Pump Station

Tarrant Regional Water District constructed the Richland-Chambers Project between 1984 and 1989. The intake facilities were constructed in 1985, before the lake was completed. The pump station was bid in 1987 and completed in 1989. The pump station is located on the northern shore of Richland-Chambers Reservoir. Access to the pump station is off State Highway 309 between S.H. 31 and U.S. 287 east of Corsicana. County Road 3250 provides access to the site. A location map is shown as **Figure 3-6**.

The intake facilities include an intake tower in the lake and two 14' square conduits connecting the intake tower to the sump on the shore. The 106'x69' sump was built on the shore with the intake facilities. The intake tower was designed for an ultimate capacity of 480 MGD at a velocity of less than 2 fps. Currently only one of the 14' conduits is connected to the existing sump. The facility was master planned for a future pump station to mirror the existing sump and pump station. The end of the northern conduit has a block out that will ultimately connect the future sump to the conduit. The two conduits can be isolated with stop gates on the intake tower.

The existing RC Lake Pump station has six 5500 HP pumps, each rated to pump 50 MGD at 529 feet of head. Three pumps are used in low capacity operations to move 147 MGD while 5 pumps are used in high capacity operations to move 250 MGD.

It is anticipated that the future pump station will also include six pump slots; however, it is not anticipated that all slots will be used for the proposed 70 MGD capacity of the Integrated System. The site includes space for the new pump station and a new substation. A site plan of the pump station site is shown on **Figure 3-7**. The location of the future pump station and the future substation is identified.

The existing 90" Richland-Chambers Pipeline runs in a northerly direction leaving the pump station site. The pipeline ROW is 180' wide. The pipeline is off-set 25' to the east of the easement centerline, 115' of the west side of the easement. A 4" waterline runs 5' off the west easement line and a 138kV power line runs 5' to 10' inside the eastern edge of the easement.

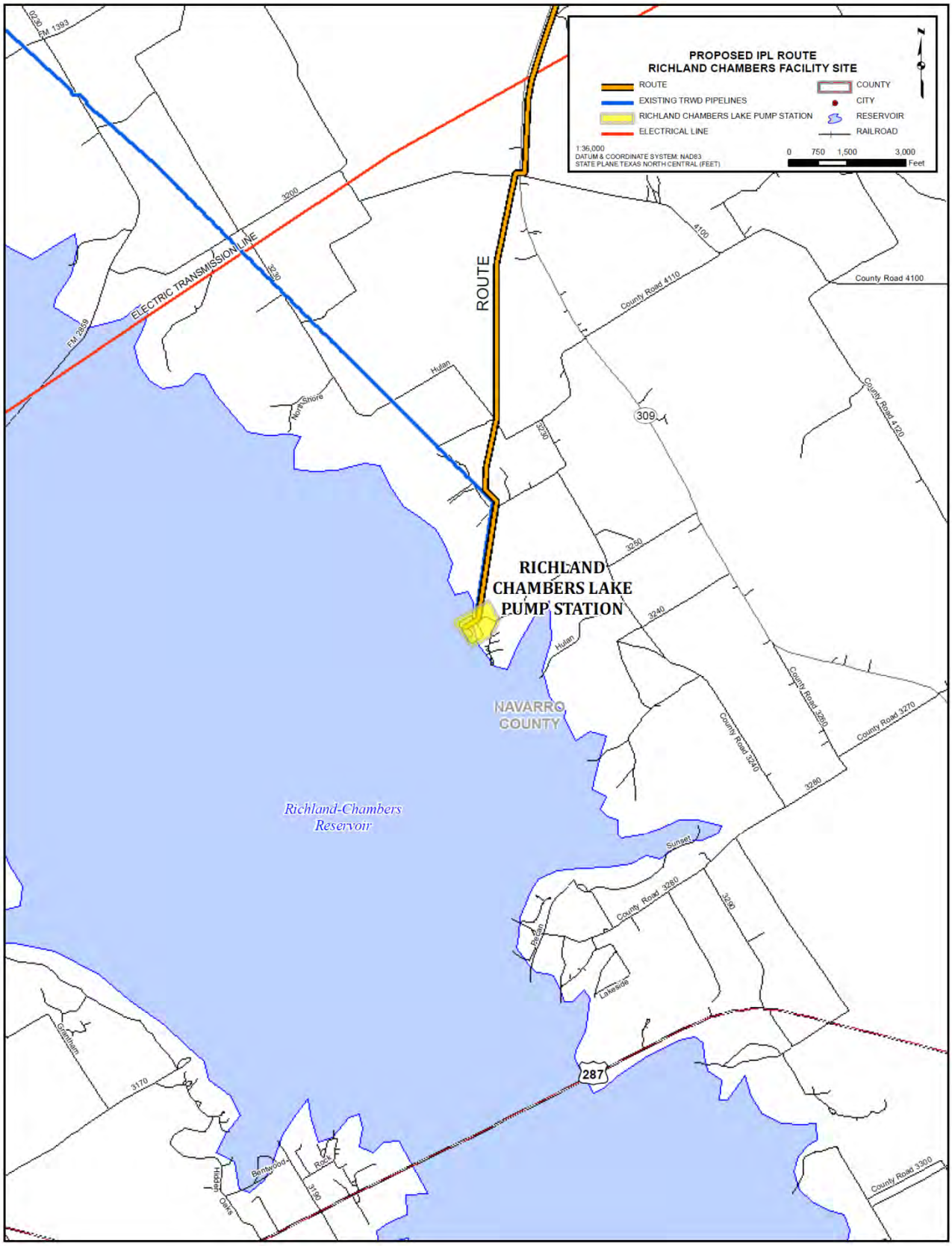

Figure 3-6. Richland-Chambers Facility Site Location

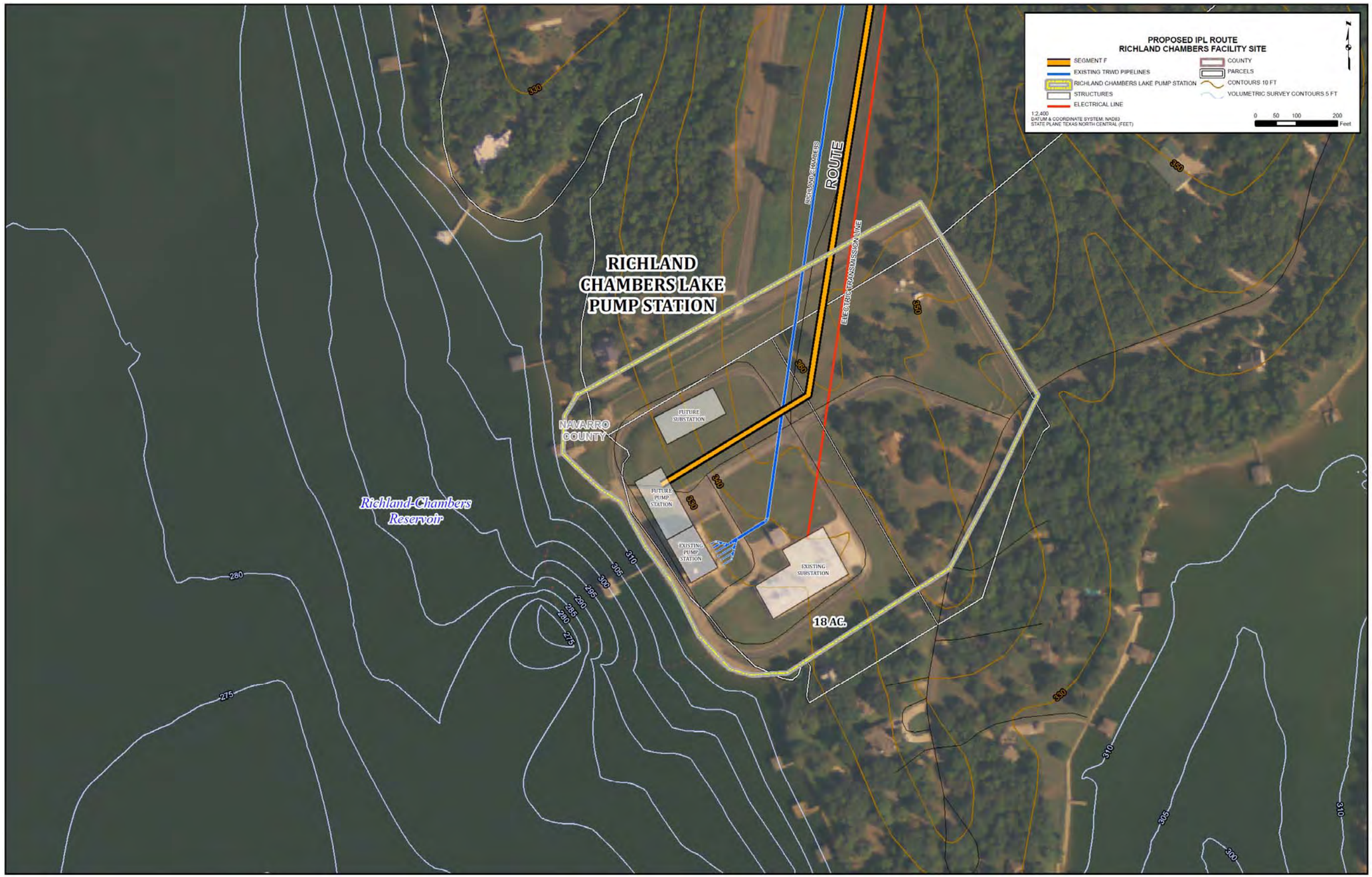

Figure 3-7. Richland-Chambers Pump Station Site Layout

3.2 Booster Pump Stations

Two booster pump stations are recommended along the main pipeline corridor to pump water west to TRWD and Dallas. The following section describes the two booster pump station (BPS) facilities. For each booster pump station, two alternate sites were chosen and evaluated with a recommendation made as to the preferred site. Evaluation criteria include access, proximity to power, soil conditions, hydraulics and ease of operations.

3.2.1 BPS 1 of 2

Two sites were considered for the location of BPS 1 of 2. Both options are located within Segment C between the Segment F Connection and I-45. The two options identified for the location of BPS 1 of 2 are referred to as:

- BPS 1 of 2, Site A
- BPS 1 of 2, Site B

A map showing the location of both options can be seen in **Figure 3-8**. The two site options are separated by approximately 15,000 LF along the proposed pipeline with option A as the more eastern and option B as the more western of the two. The existing TRWD Richland-Chambers Pipeline crosses in between these two options.

BPS 1 of 2 A

Site A, the more eastern, is located on the west side of FM 1129, near the intersection of FM 636 at Station 2990+00 of the IPL. The site is located directly off of FM 1129 and is due south of an existing electrical substation as seen in **Figure 3-9** which shows a photo of the proposed site.

Site A is bound by FM 1129 to the southeast and an electrical transmission right-of way to the north. The substation is located to the northeast of the site with a small pond immediately to the south of the substation. This end of the site has an elevation of 460 feet. The exact layout and location of the site depends on the type of storage facility chosen. Two options have been considered:

- Ground storage tanks may be preferred hydraulically to try and match the high points on Segment A of the pipeline. It is anticipated that the top of pipe can be set at an elevation of 525. The storage tanks could have a bottom elevation of 450 and a top elevation at 525 to keep the pipeline full and prevent the line from draining into and overflowing the tanks. The downside is the cost of taller tanks and the number of tanks that would be required to provide the adequate storage to ride through a power outage at one pump station site.
- An alternate operational concept is to build an earthen reservoir for increased storage to allow one pump station to ride though a power outage at another site. For large volumes of storage, an earthen reservoir is more cost effective. The downside is that the optimum embankment may only be 30 to 40 feet in height. As this site may have a bottom elevation of 440 feet MSL, the maximum water surface elevation for this reservoir may be only 470-480 feet. Enough freeboard could be built into the reservoir to allow water from the highpoint to drain into the reservoir, or an alternate means of keeping the pipeline full could be used such as a stand pipe.

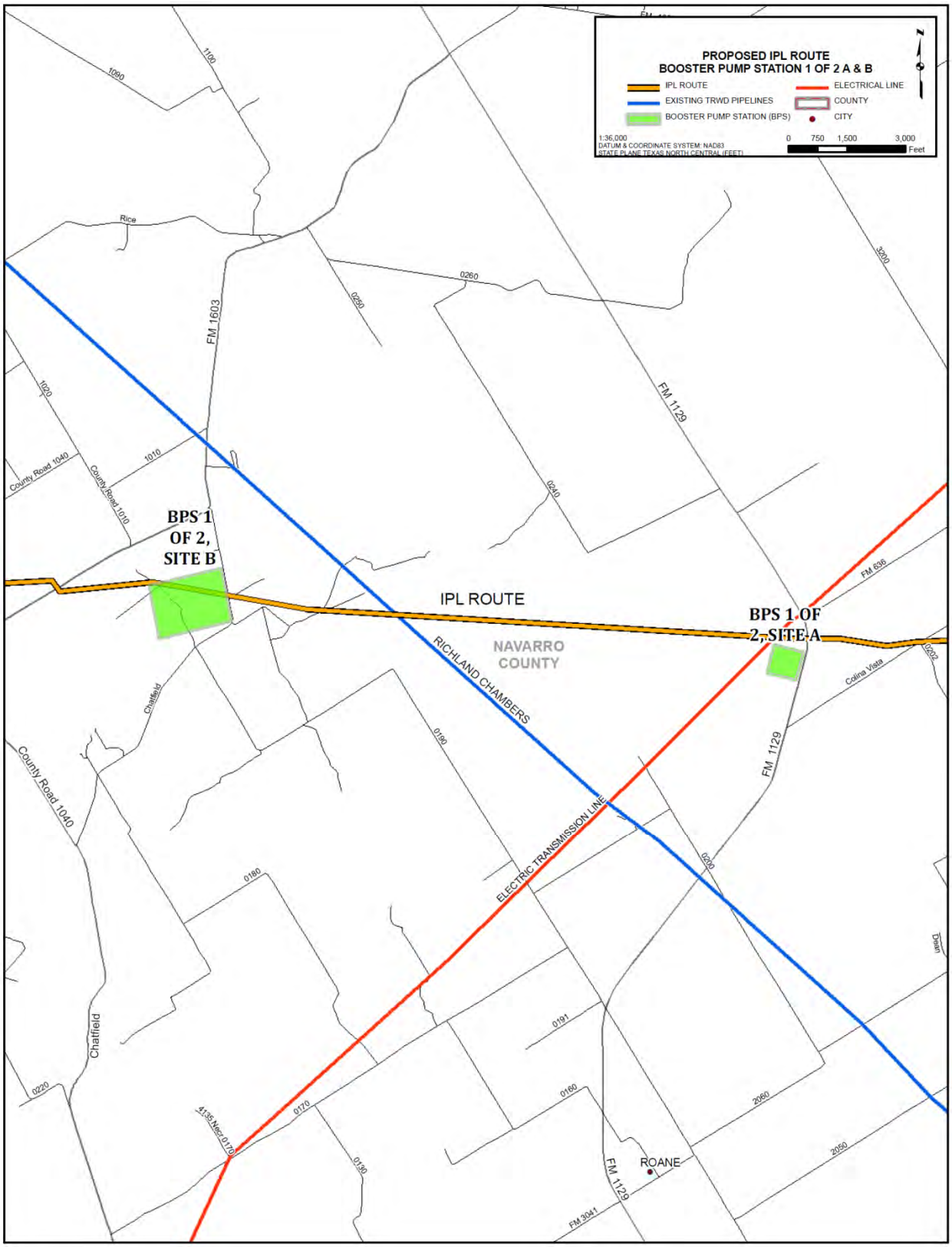

Figure 3-8. BPS 1 of 2 Location Map

If ground storage tanks are preferred, then the limits of the site should be shifted as far east as possible to take advantage of the high ground on the northeast corner and the proximity to the electrical substation. If an earthen reservoir is preferred, then the limits of the site can be shifted west to provide for more room between the highway and the electrical transmission line. See **Figure 3-10** for site details with the possible site boundaries and contours.

Figure 3-9. BPS 1 of 2, Site A, Facing West

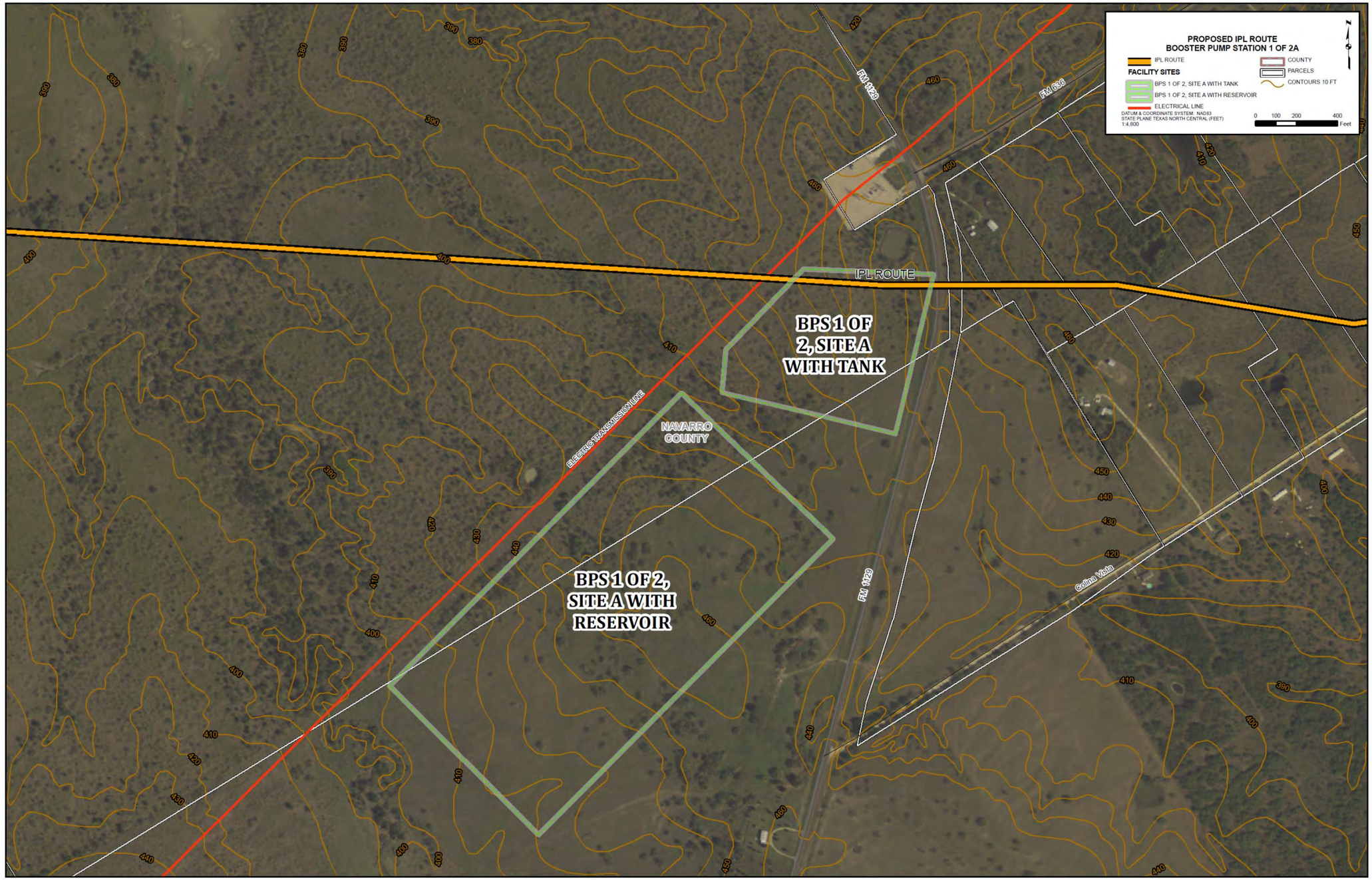

Figure 3-10. Site Layout of BPS 1 of 2 A

BPS 1 of 2 B

Site B is located in a field, approximately 0.3 miles south of FM 1603, directly off of Chatfield Road. The site is near Station 3140+00 of the IPL. **Figure 3-11** shows a photo of the proposed site. The black line shows the site boundary. Included inside of the site boundary will be the reservoir and pump station.

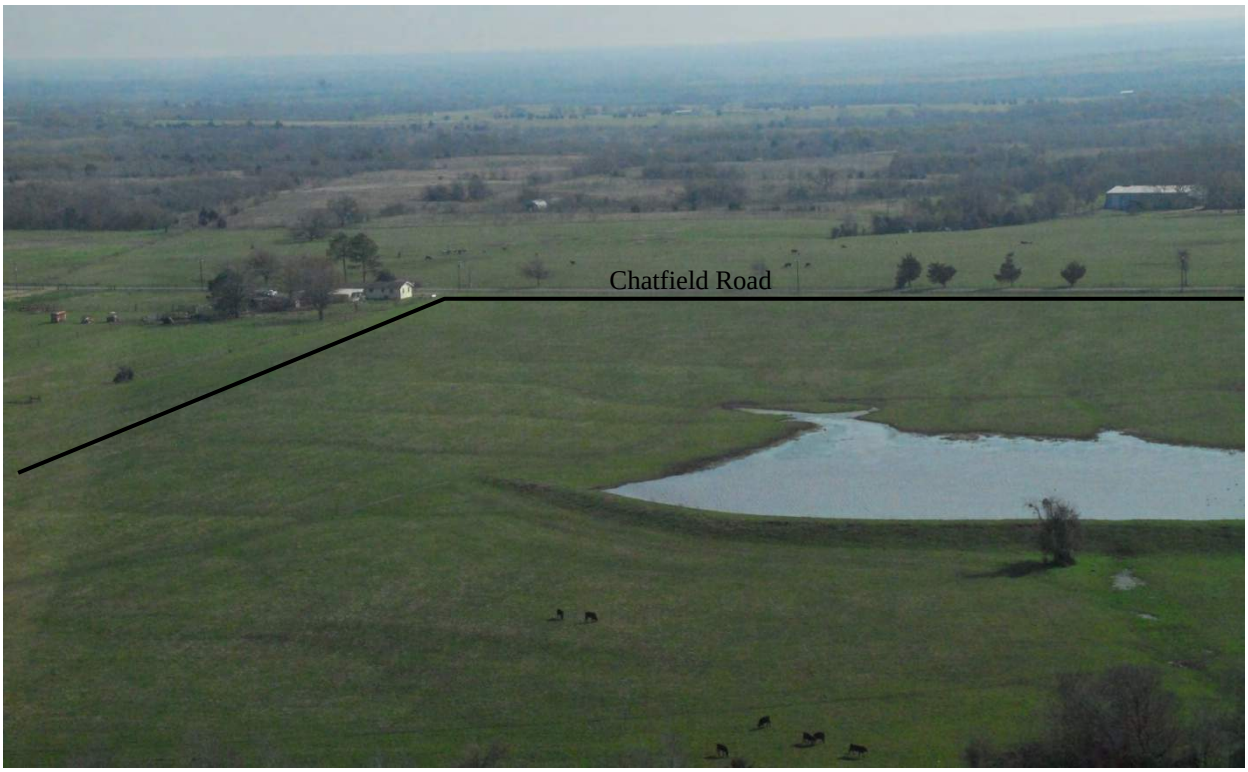

Figure 3-11. BPS 1 of 2, Site B, Facing East

Option B is on a large, relatively flat area that will allow for an earthen reservoir and pump station. The proposed site is approximately 61 acres, providing room for a 1,200 foot by 1,200 foot earthen reservoir. The footprint of the reservoir may be decreased, while maintain volume, pending site specific cut and fill requirements. An existing earthen tank is located in the middle of the site and will need to be removed during construction of the reservoir. **Figure 3-12** illustrates the boundary and topography of the proposed site.

Due to its location relative to the existing RC pipeline, this site allows multiple operating scenarios. The typical arrangement is for the pipeline to feed into the reservoir and then gravity flow into the suction side of the booster pump station. A line is needed to bypass the reservoir to connect directly to the suction side of the pump station. This will allow pumping when the reservoir is down for maintenance. A standpipe could be installed on this leg to control system pressures. A bypass around the reservoir and pump station will also be needed to allow pumping directly from the lakes to the second booster pump station. Lastly, a pipeline could be built back to the RC pipeline, approximately 4,800 feet, to allow for pumping through either the proposed IPL or the existing 90” RC line.

Site B is located on the west side of the connection to the RC Pipeline. This allows for water from Richland-Chambers to be pumped to BPS 1 of 2 and continue on to Benbrook or to be routed back to the RC Pipeline and potentially bypass the Ennis Pump Station.

The pump station may have either horizontal or vertical turbine pumps and will be located downstream of the reservoir at a lower elevation to allow the reservoir to drain completely.

Comparison of BPS 1 of 2 Sites

Property - Site B holds size advantages as it is larger in area than Site A. Site A is limited due to the restriction of the electrical transmission line on the northern boundary of the site. Although an earthen reservoir could be built on either site, Site B lends itself more to reservoir construction.

Geology - A preliminary analysis of the soils and geology in both locations was performed. The National Cooperative Soil Survey and the Geologic Atlas of Texas were used for the analysis. The soil for Site A is mostly comprised of clay. The main issue for concern with the clay at Site A is the soil's propensity to shrink and swell. For the tank, there will need to be possibly 10 to 15 feet of excavation and backfill for site improvement to prevent any shrinking and swelling. The soil for Site B is comprised of multiple soil types with the majority being sandy loam. Shrink and swale is less of an issue for Site B than Site A. The soil type is favorable for a reservoir on Site B; however, if the reservoir is cut deep enough, it may encounter a sandy formation which could cause water loss. The use of a clay or synthetic liner can be used to prevent this from occurring. There is not much difference between how the soils at the different sites will affect the pump station, but the soils at Site B are slightly more favorable.

Access - Site A has great access to a nearby power source and is directly off of an FM highway. Site B also has good access to roads, as it is situated directly off of Chatfield Road which intersects FM 1603 approximately 0.3 miles north of the facility site. However, the closest electrical substation to Site B is approximately 3 miles to the east.

Operations and Hydraulics - The ability for Site B to have a reservoir greatly increases its operation and storage capabilities. In general, the further west the booster pump station is located, the less pipe above 250 psi is required downstream of BPS 1 of 2. See **Figure 3-13** for the hydraulic profile showing the pipe pressure. Furthermore, with Site B on the west side of the RC Pipeline connection, water from the Richland Chambers Reservoir can be pumped to the reservoir at Site B and through the IPL.

There are several high points along the pipeline that are upstream of both sites and reach higher elevations than both sites. One high point is at elevation 550 feet MSL while the others are at 530 feet MSL.

The bottom of the tank at Site A would be at an elevation of 450 feet MSL. With an 80 foot tall tank, the max elevation of the tank will be 530 feet MSL to match several of the high points upstream. If Site A is chosen for BPS 1 of 2, the high point which reaches an elevation of 550 feet will have to be deep cut to an elevation of 530 feet for approximately 1,000 feet along the IPL. This will ensure that the tank at Site A does not overflow during pump stoppage.

Figure 3-12. Site Layout of BPS 1 of 2, Site B

It is anticipated that the reservoir at Site B will be approximately 30 feet tall with a ground elevation of 460 feet MSL and a max water level of 490 feet MSL. Note that the elevation of the pipeline upstream of Site A rises above 490 feet MSL. When pumps are not running, the water in the pipeline above 490 feet will flow by gravity to the reservoir causing potential overflow events. However, overflow can be prevented with sufficient freeboard in the reservoir. The high points along the pipeline create valleys that will store the water and remain full. In the event of a power outage, water remains inside the valleys and drains from only a portion of the pipeline. The total volume of water in the pipeline that will not be contained in valleys, but will feed into the reservoir is slightly over 1MG. With a reservoir having an inside perimeter of 1,000 feet by 1,000 feet, the freeboard required to prevent overflow is less than two inches. **Figure 3-13** features the hydraulic grade line of the pipeline from Lake Palestine to BPS 1of 2 and it shows the valleys created by the high points.

If freeboard is used on the reservoir at site B for water to drain into, the 550 foot high point will not need to be deep cut. Using freeboard at Site A requires the water tank to be approximately 250 feet in diameter which rules this operation scenario out. Thus, if site A with a tank is selected, the high point reaching 550 feet MSL upstream of the site must be deep cut for 1,000 feet.

Utilizing freeboard as discussed for site B results in portions of the pipeline being dewatered during pump stoppage. This necessitates special considerations during the start up of pumps while filling the pipeline. If avoiding dewatering of lines is preferred during pump stoppage, a standpipe with an overflow weir could be implemented at site B. A standpipe is required to hold water at an elevation of 530 feet MSL resulting in an approximate 70 foot height. During normal operation the standpipe is bypassed to lower static head. During pump stoppage, the bypass valve is closed to prevent dewatering the pipeline. Like Site A, a standpipe at site B requires upstream pipe to be deep cut so as not to exceed an elevation of 530 feet.

Recommendation

Site A holds power access advantages as it is next to an electrical substation. However, due to hydraulic advantages including the ability to better utilize the RC connection and the ability to house a reservoir, site B is preferred. **Table 3-4** outlines a comparison of the two options. An "x" indicates which site is preferred per category. If both options are marked with an "x" they are considered equal.

Table 3-4. Comparison of BPS 1 of 2

Criteria	Site A	Site B
Operations		x
Hydraulics		x
Size		x
Elevation		x
Road Access	x	x
Power Access	x	
Geology		x

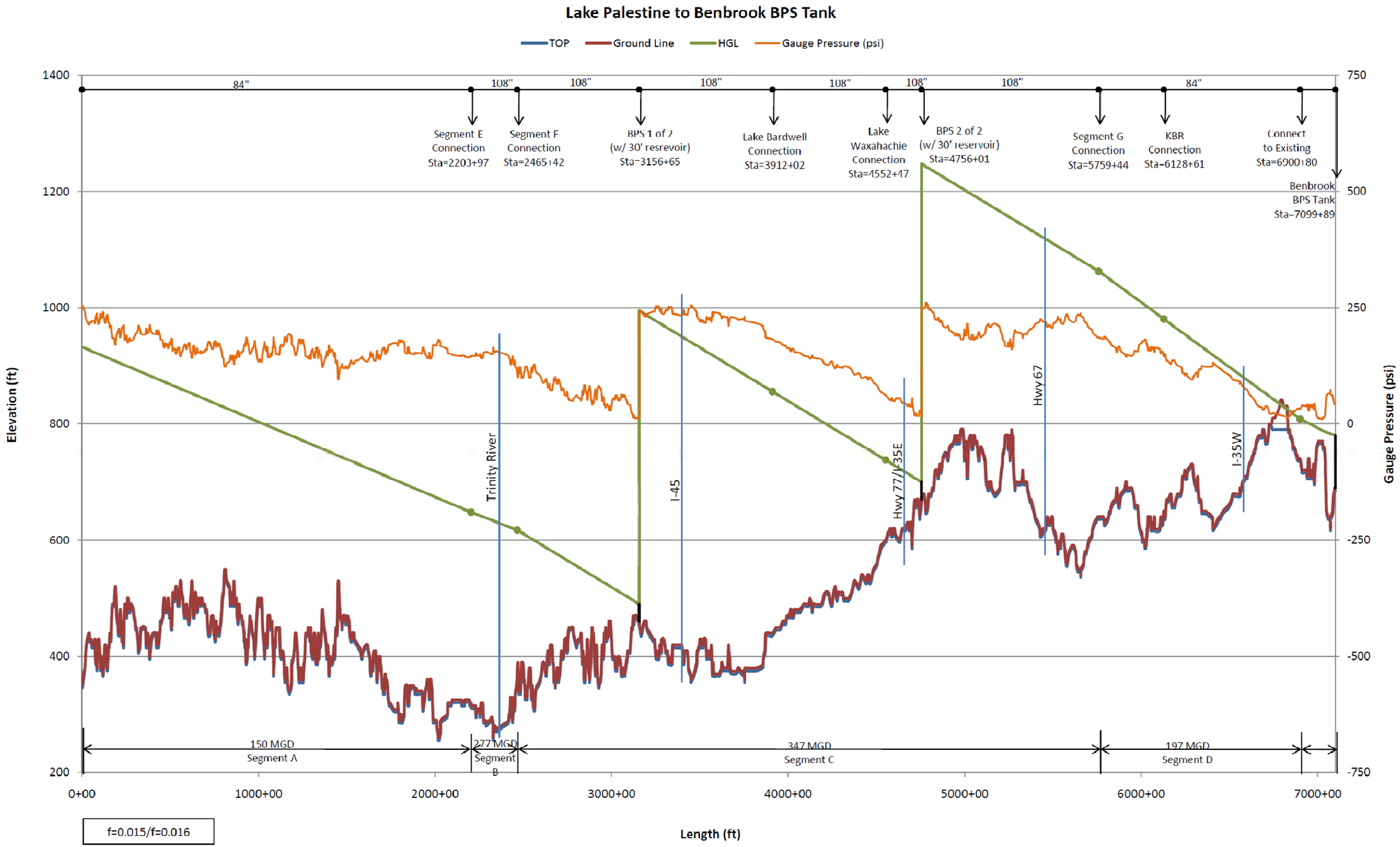

Figure 3-13. HGL for IPL from Lake Palestine to Benbrook BPS Tank

3.2.2 BPS 2 of 2

The second booster pump station is also located on Segment C of the pipeline, approximately three to four miles west of I-35E. This is roughly four miles southwest of Waxahachie. See **Figure 3-14** for location details. There are two possible sites identified for this booster pump station:

- BPS 2 of 2, Site A
- BPS 2 of 2, Site B

The sites are about a mile apart, separated by FM 66. Site A is the eastern most while site B is the western of the two options. The elevation of the pipeline route in this area is climbing towards a high point near Midlothian which is about ten miles further northwest along the route. The Midlothian highpoint is approximately 790 feet MSL. A substation is located approximately 4.5 miles southwest of the sites where a transmission line and FM 66 intersect as seen in **Figure 3-14**. Both sites are approximately 130 acres in size to accommodate a BPS and a reservoir. The reservoir will be approximately 1,200 feet x 1,200 feet with 30 feet of water depth and five feet of freeboard resulting in a capacity of 90 MG which provides 6 hours of storage at a demand of 350 MGD. The footprint size is worst case and could likely be reduced pending site specific layout and detailed cut and fill balance.

C7 BPS 2 of 2, Site A

Site A is located southeast of FM 66. Access could be obtained by turning southeast off of FM 66 onto Cunningham Road. Cunningham Road would be followed for 0.3 miles before turning southwest onto Old Maypearl Road. The BPS site is located 1,000 feet down Old Maypearl on the southeast. Old Maypearl curves around the site bounding two sides. Thus, multiple access options are possible.

The selected site is an approximate 2,400’ x 2,400’ cultivated field. The surrounding area is rural pasture and cropland with development primarily along FM 66. Adjacent land could be available if future expansion is anticipated.

The site slopes from 690 feet MSL to 640 feet MSL. A reservoir on the site could have a bottom elevation of approximately 660 feet while the pump station could be built at elevation 650 feet. This would require the reservoir being in the southwest portion of the site to keep it as high as possible. The pump station is laid out to be in the northeast portion of the site to keep it as low as possible. See **Figure 3-15** for site details including contours. Such a configuration, with the bottom of the reservoir above the pump station, would allow the full capacity of the reservoir to be utilized and would improve pumping performance. Also, designing the pump station to be lower than the reservoir would broaden pump choices allowing the use of either horizontal or vertical turbine pumps. If a tank were implemented in place of an earthen reservoir, the site size could be reduced.

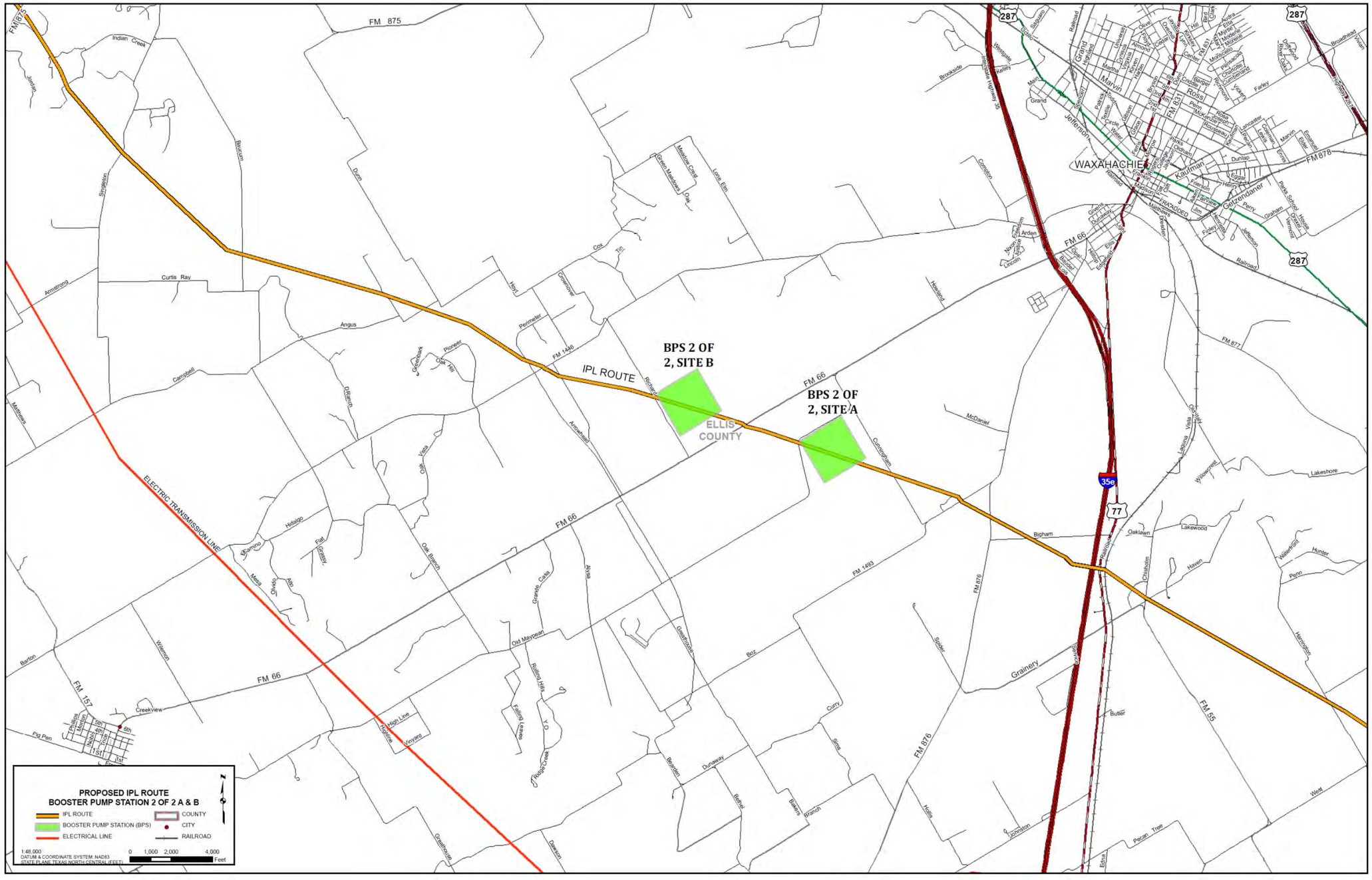

Figure 3-14. BPS 2 of 2 Location Map

Figure 3-15. BPS 2 of 2 A Site Layout

C7 BPS 2 of 2, Site B

Site B is situated northwest of FM 66. It can be accessed by turning northwest from FM 66 onto Richard road. The site is approximately 1,200 feet down Richard on the northeast side of the road.

Like site A, site B is approximately 2,400' x 2,400' in size. It is situated on pasture with the surrounding area also being rural pasture. Adjacent land could be available if future expansion is anticipated.

The site slopes from elevation 740 feet to 680 feet. Similar to site A, a reservoir could be built in the southeast corner while the pump station would be built in the northwest corner. See **Figure 3-16** for site details with contours. The bottom of the reservoir would likely be at elevation 700 feet with the pump station at elevation 690 feet. The full capacity of the reservoir could be utilized and the elevation difference between the reservoir and pump station would benefit pump performance. If a tank were implemented in place of an earthen reservoir, the site size could be reduced.

Comparison of BPS 2 of 2 Sites

Property - Both sites are almost identical in size and shape. According to the Natural Resources Conservation Service (NRCS), both sites are composed almost entirely of Austin silty clay as classified by the National Cooperative Soil Survey. Clay soil is preferred for earthen reservoirs. Thus, both sites are expected to be feasible from a geological perspective if an earthen reservoir is selected.

Access - Site A is slightly further off of FM 66, but the pump station is situated close to the front of the property. This results in a short access road that would need to be built on the property. The pump station on Site B is located back away from the road requiring the construction of a much longer access drive. The sites are very similar from a power aspect.

Operations and Hydraulics - The pump station at Site A is located about 50 feet lower in elevation than site B. As seen by the hydraulic profile, **Figure 3-13**, lowering the elevation is preferred. This would decrease the pressure in the pipeline segment between the two booster pump stations where the pressure class reaches above 250 psi.

Figure 3-16. BPS 2 of 2 B Site Layout

Recommendation
The two proposed sites are very similar and offer many of the same benefits. Once the sites are evaluated in detail on the ground, more information may become available setting one substantially better than the other. Currently site A is preferred and recommended. This is primarily due to the vertical advantages and shorter drive length. **Table 3-5** outlines a comparison of the two options. An "x" indicates which site is preferred per category. If both options are marked with an "x" they are considered equal.

Table 3-5. Comparison of BPS 2 of 2

Criteria	Site A	Site B
Operation	x	x
Hydraulics	x	x
Size	x	x
Elevation	x	
Road Access	x	
Power Access	x	x
Geology	x	x

3.3 Storage

3.3.1 Crowley Terminal Storage Reservoir

The Crowley reservoir site is located near the end of IPL segment D approximately 0.5 miles east of where Old Granbury road and Rocky Creek Park road meet. The site is an alternate option in the case that the Crowley deep tunnel is not built. In such an instance, the IPL will route south of the Crowley High School before turning north to make the Benbrook pipeline connection. The reservoir site is located west of the anticipated Southwest Parkway toll road. See **Figure 3-17** for site location.

The site is sized at 2,860 feet by 1,620 feet or approximately 105 acres. The site allows room for two 200 MG reservoirs. One reservoir would be built initially providing one day of storage. The second reservoir would be built later as system demands grow.

The site is located on rural pasture and could be accessed using FM 1902 which is just west of the site. The site is at elevation 870 feet MSL. According to NRCS, the site soil is classified by the National Cooperative Soil Survey as 50% Purves clay and 33% Aledo gravelly clay loam. The remainder of the soil composition is composed of Medlin and Sanger clay.

The Crowley reservoir option offers several operational benefits as listed below:

- Provides a full day storage in case of system downtime.
- Allows for constant pumping rates with changes in demand patterns absorbed by storage.
- Open water surface provides a surge break.
- Open water surface limits system from over pressuring due to accidental control valve closures.
- Provides a delivery point for the future Southwest WTP proposed by Fort Worth.

- Allows for delivery by gravity to Benbrook Outlet Structure, Clear Fork Outlet Structure, Benbrook Water Authority, Weatherford PS, Benbrook BPS, Rolling Hills WTP, and the Kennedale Balancing Reservoir.

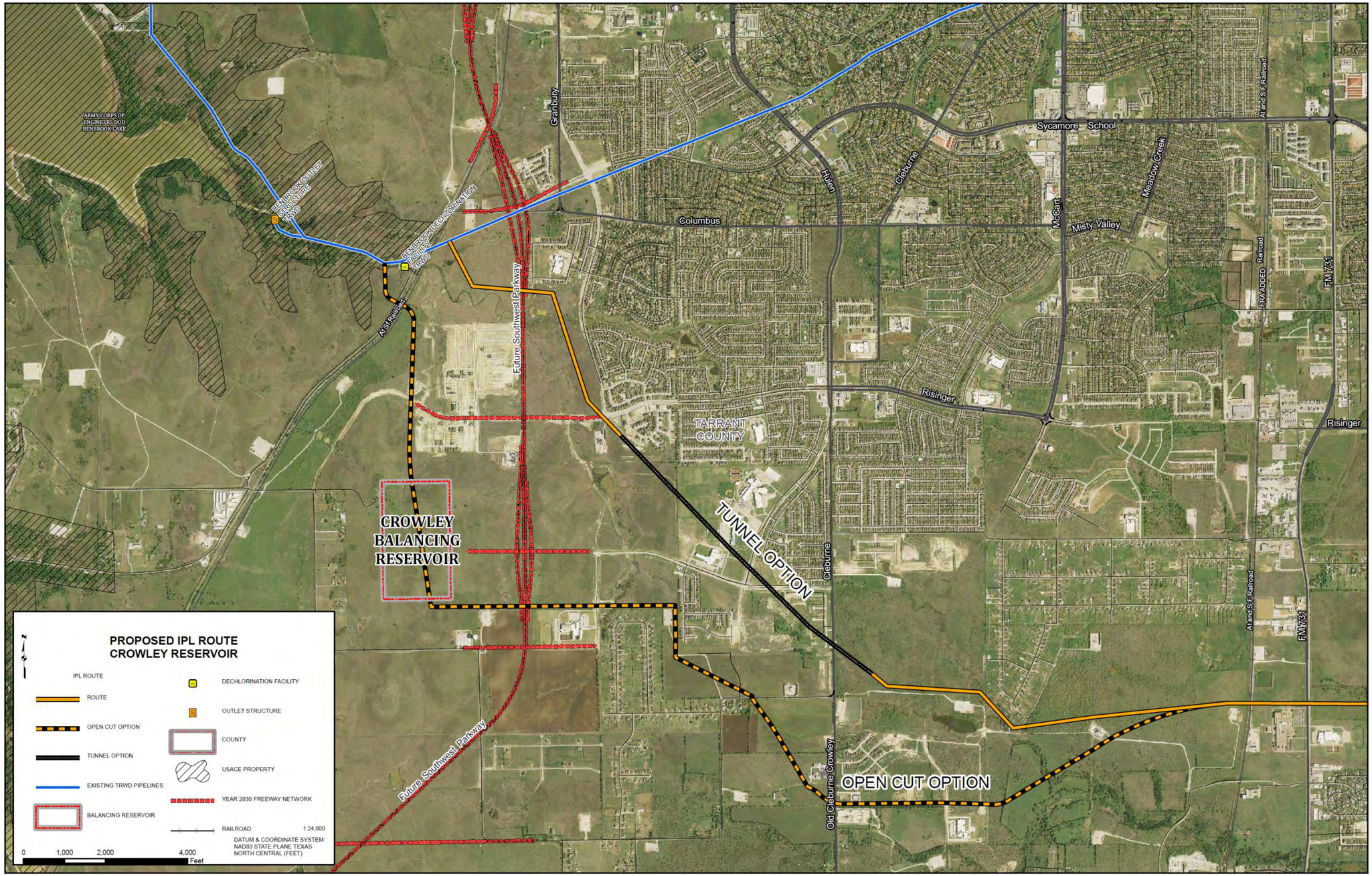

Figure 3-17. Crowley Terminal Storage Reservoir Location

Section 4
Hydraulic Evaluation

Prior hydraulic assessments have been presented in *Amendments 3 and 4 of Phase 1 of the Raw Water Transmission System Integration Study Report No. 2* and address peak capacity evaluations for multiple corridors of the proposed transmission pipeline. Since completion of Report No. 2, the corridors have been further refined into a selected corridor which includes a re-route from the corridor recommendations included in Report No. 2. Specifically, this revision impacts segments C and D using a new corridor 7B which changes the alignment to south of Bardwell Reservoir and Lake Waxahachie and takes advantage of a slightly lower peak elevation at the Midlothian high point. The corridor changes are discussed in greater detail in Section 2 of this report.

This Section 4 focuses on the proposed integrated pipeline revised hydraulic criteria and hydraulic performance including pipeline sizing and capacity/power requirements for the pumping stations based on the most recent corridor revisions. Specific corridors and pump station locations have been identified and facility sizing has been established for the revised corridor. This section also includes the basic decision matrix information (associated with hydraulic performance) for the revised corridor.

4.1 Hydraulic Design Criteria

The various hydraulic criteria to be used in establishing pipe sizing, pumping capacity, total dynamic heads and power requirements are detailed in the following sections. Most of the design criteria are unchanged from Report No. 2 and the reader is referred to that report for more detail. Any changes to those previously established criteria are identified and clarified herein. Criteria used in conducting the hydraulic analysis are summarized comprehensively within this section (whether established in Report No. 2 or No. 3).

4.1.1 Pipes

Design Flows

Development of demand allocation and subsequent flows by pipe segment has been established in previous reports. The CDM team has been directed to use the peak flows summarized in **Table 4-1** for purposes of sizing the integrated pipeline facilities. These flows represent peak, future hydraulic flow requirements by pipeline segment serving TRWD and Dallas. **Figure 4-1** illustrates all pipe segments of interest on the project.

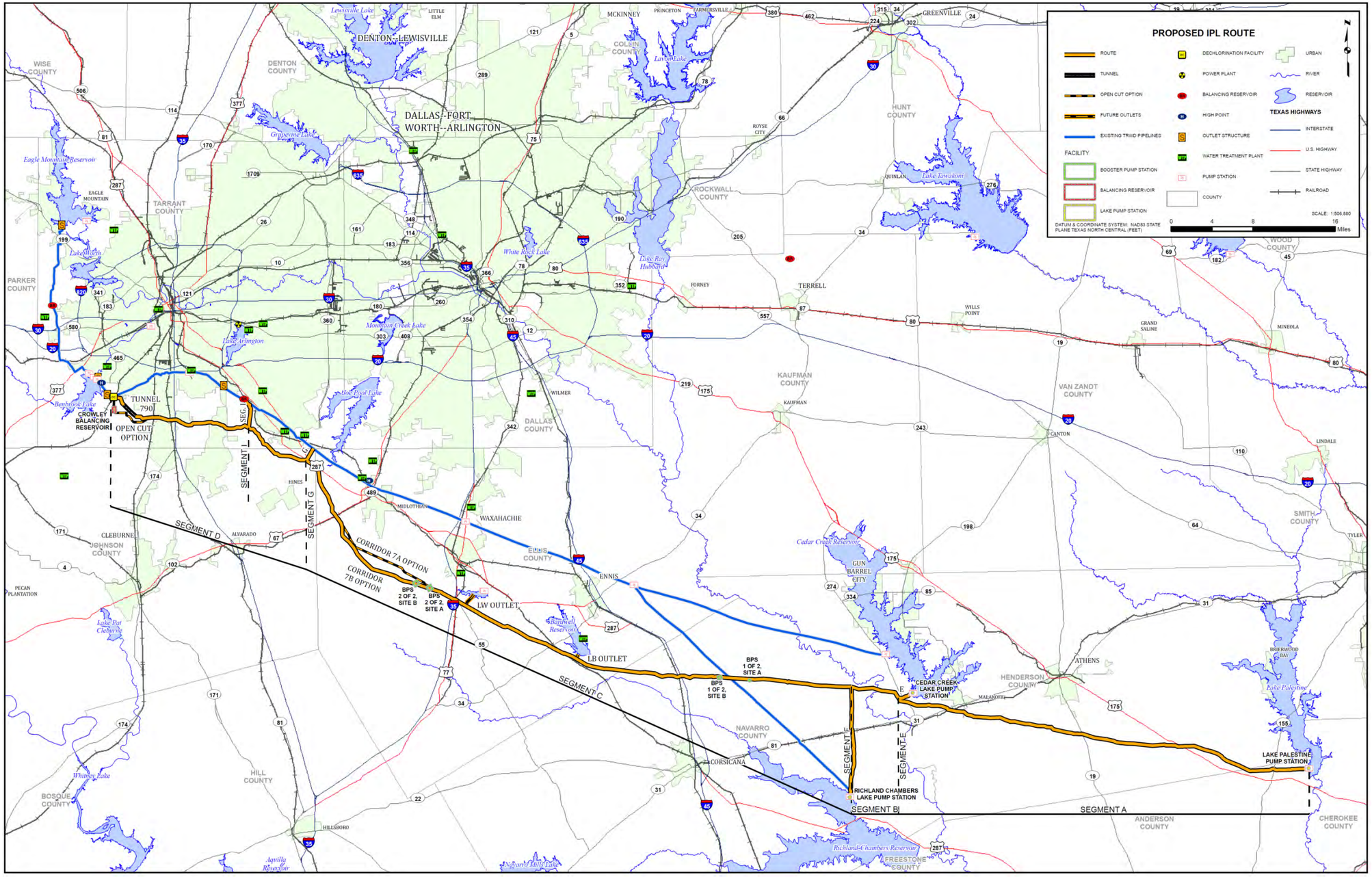

Figure 4-1 Integrated Pipeline Route Overview

Table 4-1. Design Flows by Pipe Segment

Segment	*TRWD Capacity*	*DWU Capacity*	*Total*
	(MGD)	*(MGD)*	*(MGD)*
A	0	150	150
B	127	150	277
C	197	150	347
D	197	0	197
E	127	0	127
F	70	0	70
G	197	150	347
H*	0	150	150
I	197	0	197

*- Peak Dallas flows delivered to a takeoff point at the upstream end of Joe Pool Lake for delivery to Dallas in an as-of-yet undetermined configuration

Friction Factors

Various hydraulic criteria and friction loss assumptions have been established for previous analyses of the Integrated Pipeline. Use of the Colebrook-White formula to predict friction factors is recommended for this phase of planning utilizing the Darcy-Weisbach formula with an absolute roughness value of 0.003 feet. As discussed in Report No. 2, this approach produces similar results to a Hazen Williams C coefficient of 120 (although slightly more conservative). This increased conservatism should be adequate to represent both minor and dynamic friction losses in the transmission piping system at this level of planning. During final design, this approach will be developed further into distinct analyses as recommended under the design standardization.

Pipe Sizing

Optimization of pipe sizing has been performed by comparing capital investment costs versus energy costs on a present worth/life cycle basis. The methodology and results are the subject of separate technical memoranda included in Appendix F and entitled:

- "Transmission Pipe Size Selection – Life Cycle Costs Analysis and Assumptions and Findings" dated July 20, 2009.
- "Infrastructure Sizing, Tunneling, and Pump Station Configuration Analyses – Findings and Conclusions" dated December 17, 2009.
- "Infrastructure Sizing, Tunneling, and Pump Station Configuration Analyses – Findings and Conclusions-Updated" dated February 24, 2010.

Although conclusions indicate that current pressure and velocity limitations and friction criteria are sound for planning level pipe sizing, comparisons between a selected size and one standard pipe size larger and one standard size smaller are comparable in terms of life cycle cost. The analysis is quite sensitive to the length of the life cycle period, demand impacts (and therefore pumping energy used) after 2030, material cost quotations for pipe manufacture and delivery, energy costing assumptions, and impacts of energy savings (vs. capital expenditure) for tunneling. Therefore, additional life cycle and related sensitivity analyses are planned during the

IPL conceptual design phase to optimize pipe size for each segment and facility selection by location. As a result, the final pipe and facility sizing is subject to change from those recommendations included herein.

Table 4-2 identifies the peak flow rates and corresponding pipe sizes used for the hydraulic analysis and form the basis for this analysis.

Table 4-2. Design Flows and Sizes by Pipe Segment

Segment	*Design Flow*	*Nominal Pipe Size*
	(MGD)	*(Inch)*
A	150	84
B	277	108
C	347	108
D	197	84
E	127	72
F	70	66
G	347	108
H	150	84
I	197	84

Maximum Velocity and Peak Operating Pressure

Analysis of velocity and pressure limitations for a variety of piping and pumping configurations for this project indicates that a hard and fast limitation within these categories is not necessary. For example, both steel and PCCP transmission pipe can be economically designed for higher operating pressures in the range of 250 psi and life cycle costing comparisons indicate that the higher pressure pipe (in conjunction with fewer pumping stations) is cost competitive with the alternative configurations. A general limitation of 250 to 275 psi peak operating pressure (primarily at the discharge side of pumping stations) has been applied for the 2 booster pump station configurations. These maximum operating pressures have been updated from those listed in Report No. 2.

Peak velocity for the pipe segments at the designated design flow varies from about 6 to 8.5 fps while the head loss (per thousand feet) varies from about 1 to 2.25. Note that the highest head loss does not necessarily correspond with the highest velocity as this relationship is dependent on pipe size and the ratio of wetted perimeter to cross-sectional area (See Table 4-6). It is reasonable to allow some flexibility in the velocity criteria as long as the head loss is maintained in a reasonable range, low enough that particulates in the raw water will not cause damage to the pipe linings at higher velocities.

Again, these considerations are subject to change and more in depth evaluation is planned segment by segment during the conceptual design phase.

4.1.2 Pump Station

Design Station Capacities

Table 4-3 identifies anticipated pumping station capacities required to meet the future demands of TRWD and Dallas. These flow rates will provide the basis for needed pumping station infrastructure along the transmission system.

Table 4-3. Proposed Maximum Pump Station Capacities

Pump Station	*Design Pumping Rate, (MGD)*
Intake Pump Stations	
• Lake Palestine	150
• Cedar Creek	127*
• Richland-Chambers	70*
Booster Stations	347

* Capacities under bypass mode may be higher than indicated.

Pump Curves and Variable Speed Application

The preliminary pump selections include vertical turbine pumps for all three lake intake structures and a horizontal split case type for all booster pumping stations. Vertical turbine "barrel" pumps are an option for consideration at the booster pumping stations (as discussed separately as part of the on-going design standardization effort by the IPL Conceptual Design Team).

As part of pumping equipment selection the following target efficiencies were assumed at the design flows.

- Pump efficiency of 85- 90 %
- Motor, efficiency of 95 %
- Variable frequency drive efficiency of 96 %

Although achieving an efficiency of 90 percent is feasible for these large pumps, efficiency of 85 percent will be more typical which may cover a range of pump manufacturers and operating points. An operating efficiency of 95 percent is typical for premium efficiency motors operating under full load conditions. An efficiency of 96 percent is typical for variable frequency drives when operating under full load conditions.

The range of TDH requirements for the chosen pipe size and corridors are given in the **Table 4-4**. The flows and estimated pumping head have been updated from those listed in Report No. 2.

Table 4-4. Total Dynamic Head Requirements

Pump Station	*Design Pumping Rate, (MGD)*	*Total Dynamic Head (ft)*
Intake Pump Stations • Lake Palestine	150	210-625
• Cedar Creek	127 (190)[1]	136-378 (323-596)[1]
• Richland-Chambers	70 (190)[1]	143-396 (326-602)[1]
Booster Stations (2 booster) • Booster No. 1	347 (100)[1]	263-577
• Booster No. 2	347 (190)[1]	152-582

1. Assumes maximum bypass condition with a combination of pumping from Cedar Creek and Richland Chambers and main line pressures limited to approximately 250 psi.

Preliminary screening of vertical and horizontal pump applications for both the intake and booster pumps indicates that a number of offerings are available from several vendors that can meet the high head requirements with as few as 6 to 8 duty pumps (booster stations). It is anticipated that variable speed pumping will be an operational necessity to meet the full range of flows and heads while limiting the number of pump settings in each station. These pump offerings have been screened in greater detail and represent updated information since publication of Report No. 2. More information is included in the separate, on-going design standardization task deliverables from the IPL Conceptual Design Team.

Pump selection will be further refined with recommended selections for the final pipeline alignment as part of the conceptual design phase.

4.1.3 Operational Storage

Balancing reservoirs are possible at a number of locations including the highest point on segment D. This particular location for a balancing reservoir (Crowley) would enable gravity flow to the TRWD West Fork System, including Benbrook Outlet Structure, Clear Fork Outlet Structure, Benbrook Water Authority, Weatherford PS, Benbrook BPS, Rolling Hills WTP, and the Kennedale Balancing Reservoir. A decision to tunnel through the Benbrook highpoint may preclude this location for a balancing reservoir and life cycle costing appears to favor the tunneling option under some scenarios (to be refined further during conceptual design). TRWD operational experience indicates a desired storage volume of approximately 200 MG, which translates to about 24 hours supply under peak operating conditions. Doubling this storage volume in future phases (if sufficient land is available) could double emergency storage to 48 hours or more under moderate to peak delivery conditions. This criterion is acceptable for application to sizing any of the proposed balancing reservoirs in the new transmission system unless there are special circumstances to consider. Some special circumstances for increasing storage could include considerations for emergency supply in the event of an extended system outage or emergency repair and providing additional redundancy for other balancing reservoirs in the system (such as Kennedale).

For suction supply to booster pumping stations, TRWD experience has shown that 4 to 6 hours of operating storage at peak operating capacity is sufficient and provides enough reaction time for starting and stopping pump operation if warranted. Again, more storage may be appropriate if there are special circumstances. For the largest capacity booster pumping station of 347 MGD, suction storage would need to be sized between 60 and 87 MG which could be constructed in two or more phases (interim and future) to enhance operations and maximize deferral of capital investment.

Terminal storage at the delivery points to participants has not been addressed within the scope of this section and is subject to participant-specific operating rules and requirements as appropriate.

4.1.4 Reservoir Ranges/System Operating Rules

For peak flow pipe sizes, the operating levels in the supply reservoirs are summarized in **Table 4-5**. There are no real-time operating rules for pump station operation in the steady state model. For purposes of estimating maximum intake pump station hydraulic power requirements, the "minimum conservation pool" elevations were used. Since the reservoir operating ranges mostly affect pump selection rather than the hydraulic performance, maximum conservation pool was not used for this phase of analysis except to estimate ranges of required pumping head.

Table 4-5. Reservoir Ranges

Reservoir	*Minimum Conservation Pool Elevation, ft*	*Maximum Conservation Pool Elevation, ft*
Lake Palestine	310	345
Cedar Creek	282	322
Richland-Chambers	273	315
Benbrook Lake	682	694

4.2 Hydraulic Analysis

Similar to the methodology used for Report No. 2, hydraulic evaluations in this report were all conducted using MS Excel spreadsheet tools with appropriate updates to reflect modifications for the selected corridor. Specific analyses associated with flow diversions through the G and H segments (for Bachman delivery) were not performed for this updated report as these were not considered sufficiently different from the results presented in Report No. 2 and infrastructure sizing memoranda to justify additional simulation. Joint, full capacity diversions for both TRWD and Dallas through Segment G (347 mgd) requires meeting a minimum HGL elevation of 789 msl as shown in the HGL figures in this section. A split flow diversion (some flow to Benbrook and some through Segment G) requires dissipating excess head somewhere within the G segment. Although this excess head could, potentially, be recovered with hydro turbines, preliminary life cycle analysis of the excess energy utilized during these events (see Appendix H) indicates that high flow split diversions will occur infrequently and may not justify installation of energy recovery facilities.

Segment I has been sized for 84 inch and, based on the current route, a maximum HGL elevation of 773 feet at the IPL turnout has been estimated based on meeting a future maximum control elevation of 742 feet at the Kennedale Balancing Reservoir.

Hydraulic evaluation for this report focused on delivery from Lake Palestine to the Lake Benbrook area within the recommended pipeline route (see Section 2) and a range of flow conditions. As described in Section 1, a workshop meeting was held on March 16, 2010 to select the number of booster pump stations, recommend the lowest life-cycle cost pipe size, and decide if deep tunnels would be constructed through Midlothian and/or the Crowley portions of the pipeline. It was recommended during that meeting that this hydraulic analysis be completed using only the two booster pump station configuration and assuming construction of a tunnel at elevation 790’ through the Benbrook high point.

General configuration assumptions used in developing the updated hydraulic analyses include the following:

- Corridors A1 and F2 were used, consistent with the analysis in Report No. 2
- The main line corridor consists of segments A1, B, C (corridor 7B and Corridor 6), D6 as generally depicted in Report No. 2 (but representing the latest pipeline routing for Corridor 7B) and minor updates for the other main corridor segments.
- As presented in Report No. 2, intake pumping stations are represented at Lake Palestine, Richland Chambers Reservoir, and Cedar Creek Reservoir.

Figures 4-2 through **4-5** illustrate all the modeled segments A through F in detail.

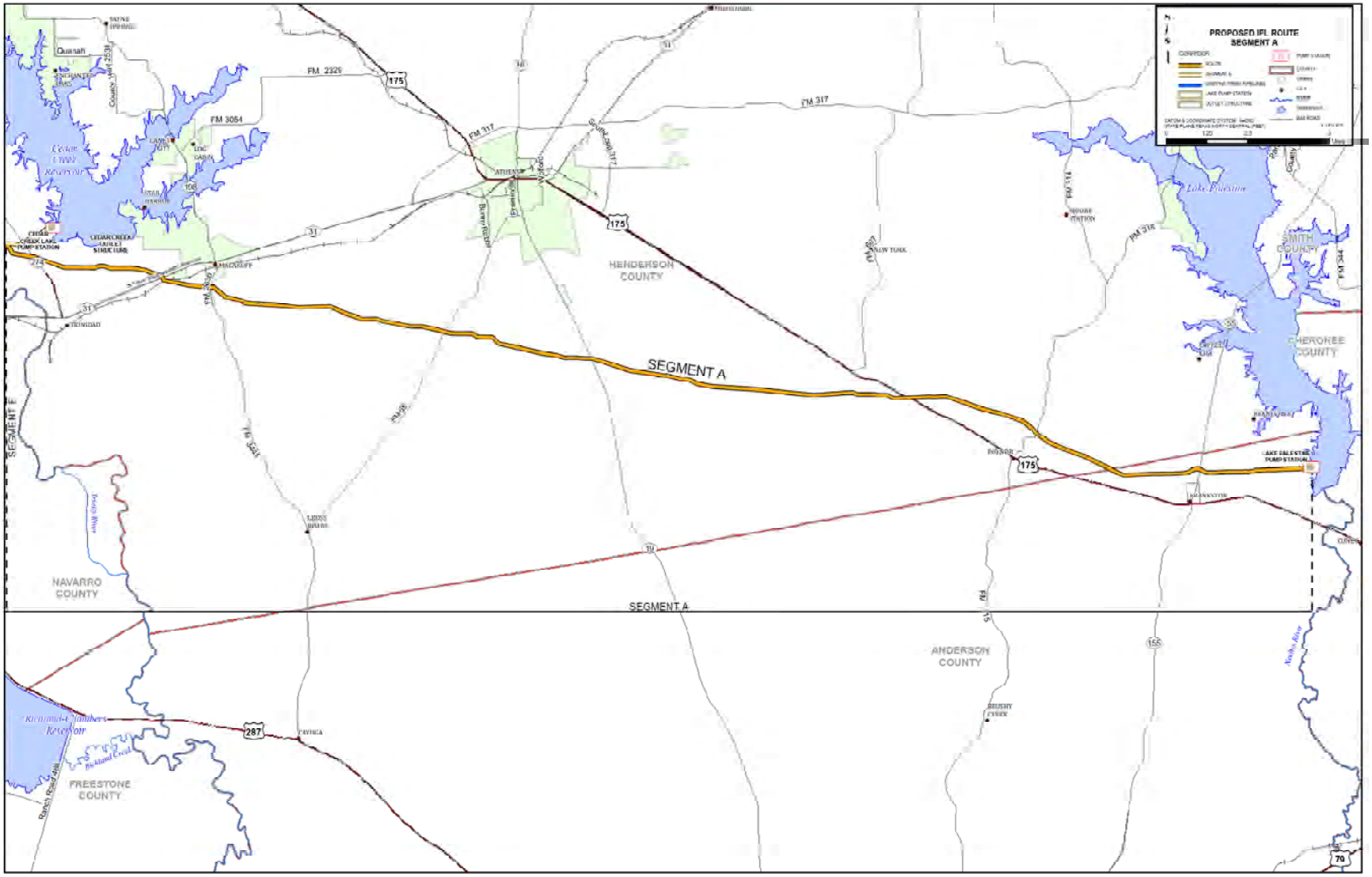

Figure 4-2. Segment A

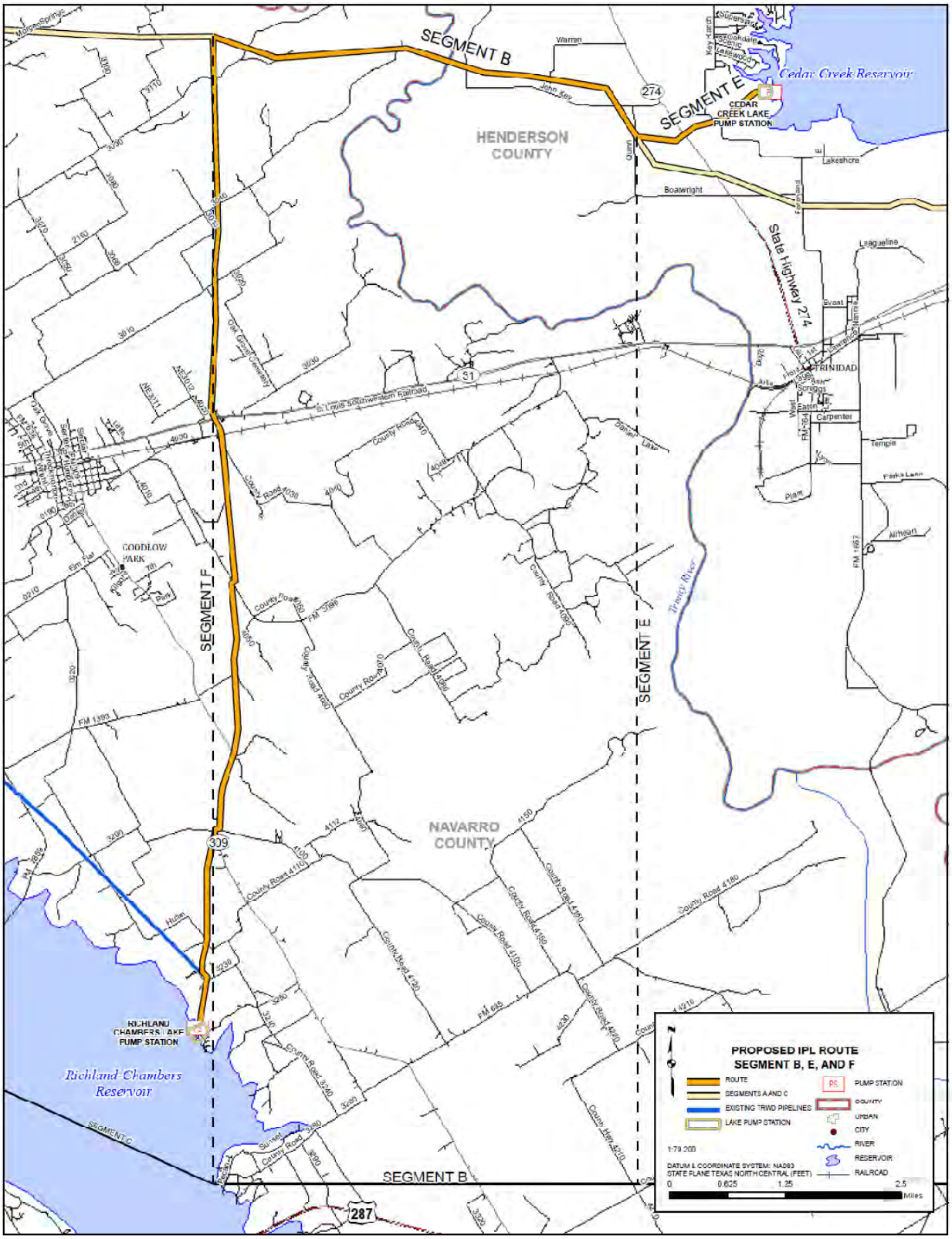

Figure 4-3. Segments B, E, and F

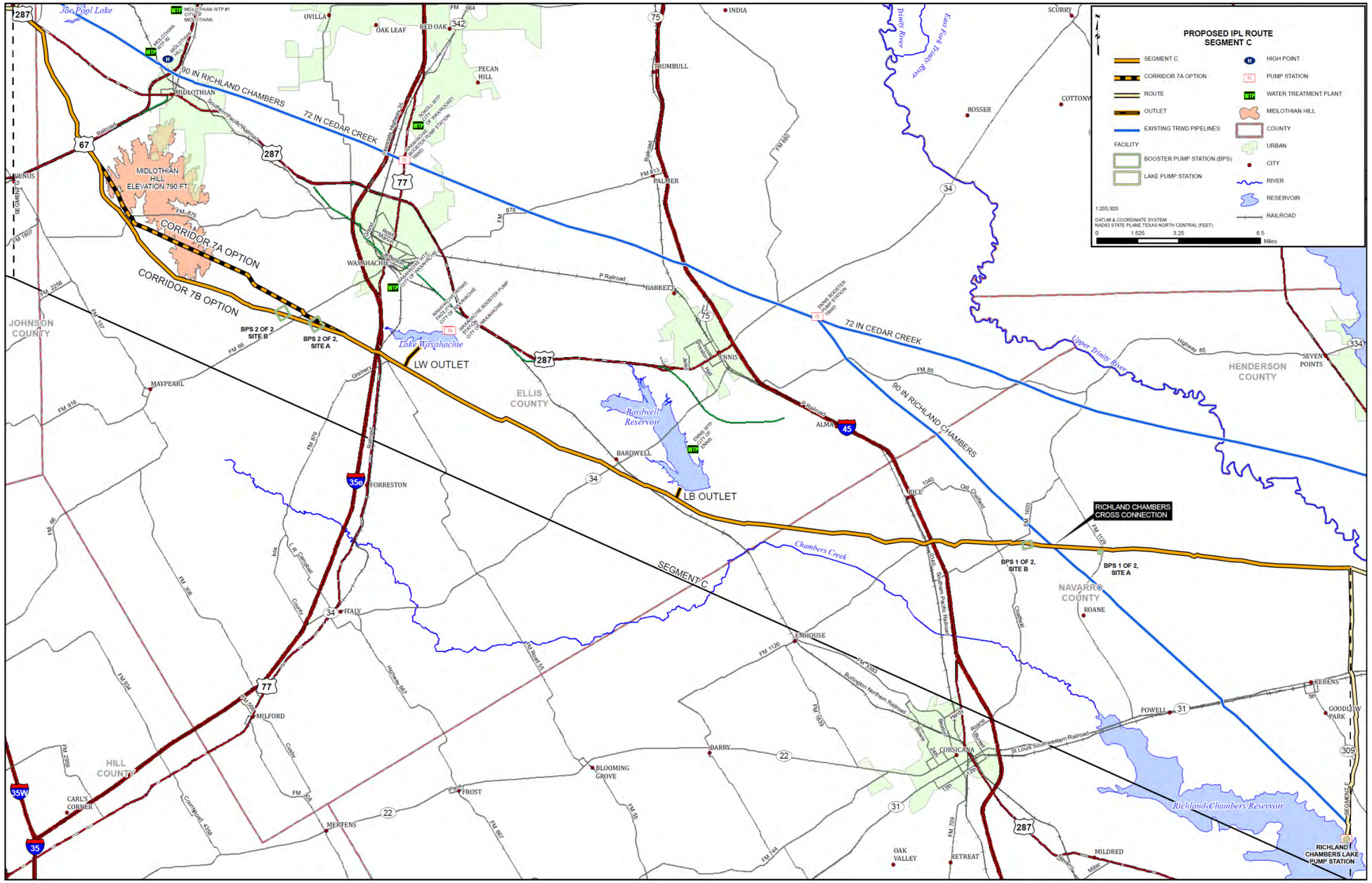

Figure 4-4. Segment C

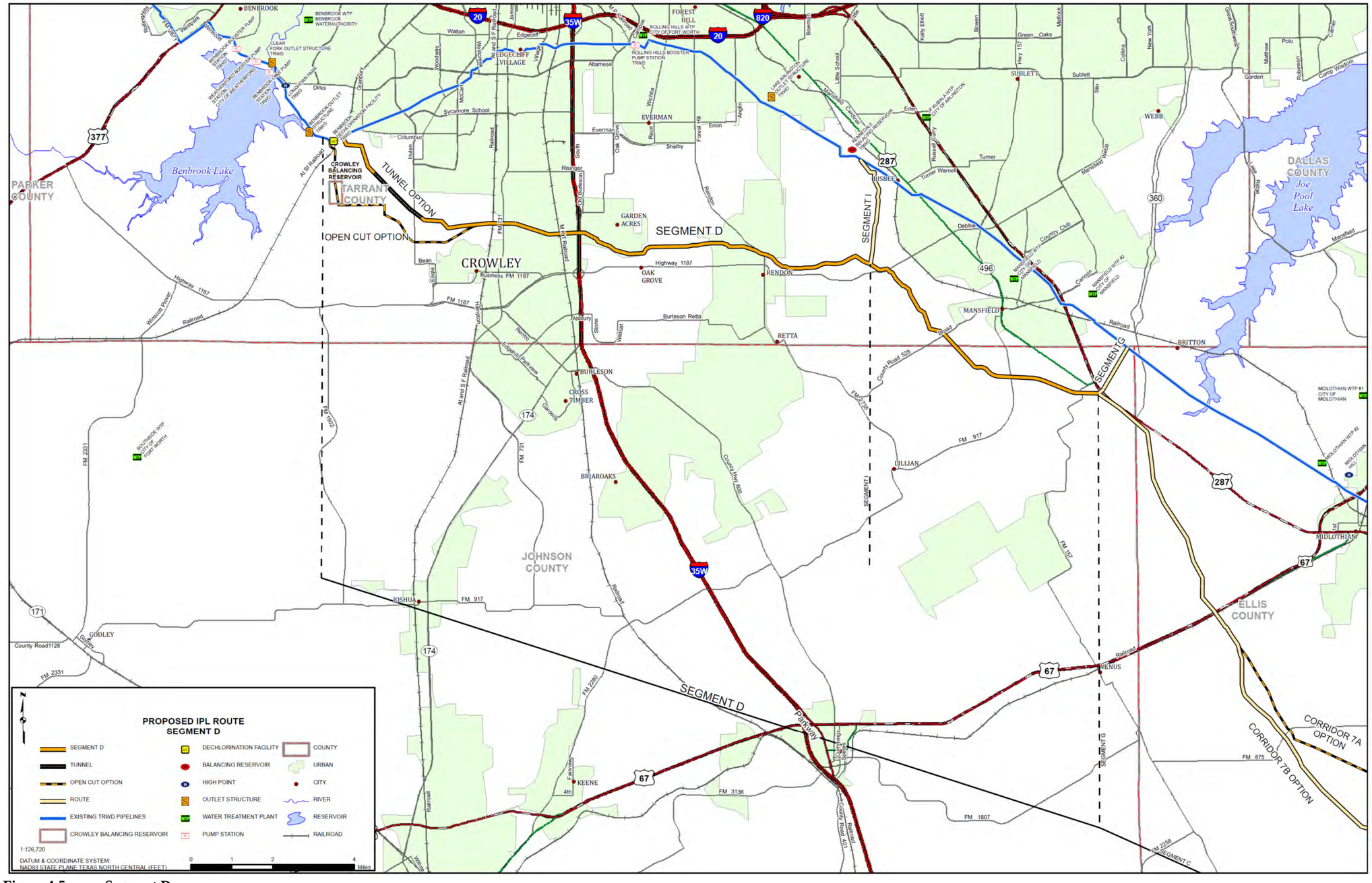

Figure 4-5. Segment D

4.2.1 Revised Corridor Results

Main Transmission Pipeline

Figures 4-6 through **4-10** depict the hydraulic grade line (HGL) performance plots for the 2-booster pump station configuration for the final pipeline corridor selected in Report No. 2 and as subsequently modified to incorporate the Corridor 7b (within Segment C) re-route.

Generally, the 2-booster pump station alternative required pumping to about 250 psi. **Figure 4-6** shows peak, future flow conditions (blue HGL) as well as 3 configurations of bypass (see later discussion) while pumping to a future balancing reservoir (Crowley) at the Benbrook high point. Two alternate sites for Booster Station No. 1 are under consideration and were modeled for hydraulic performance but only the currently preferred, alternative 1 site (western most), is presented here. For the chosen pipe sizes, the alternative 1 site helps to maintain the operating pressure on the discharge side of Booster Station No. 1 at or below 250 psi, but will potentially require portions of Segment A nearest to the Lake Palestine pump station to maintain operating pressures slightly above this limit under peak flow conditions. The situation reverses itself if the alternative 2 (eastern) site is used.

Figure 4-7 depicts the peak, future flow conditions while pumping to the 790 msl outfall elevation on the western side of the Benbrook high point (i.e. configuration with a deep tunnel through Crowley). Note that the alignment for this configuration is different from the open-cut construction with a Crowley balancing reservoir option as shown in Figure 4-5. This revised alignment slightly shortens the overall length and the highpoint above the tunnel is slightly lower in elevation, but the hydraulic performance of this alternative is not significantly affected (hence the ground profile in Figure 4-7 is the same as in Figure 4-6 to better depict the visual difference in pumping head for Booster Station No. 2).

This alternative assumes that a tunnel would be constructed through the Benbrook high point so that the HGL can be lowered under all pumping conditions to the Lake Benbrook area. This represents a lowering of approximately 80 feet of static pumping head from booster pump station No. 2 under all operating conditions that pump west towards Benbrook. However, gravity delivery to the Rolling Hills WTP from a balancing reservoir located at the high point would be precluded under this scenario. Further evaluation of the pros and cons of these alternatives will be needed during conceptual design (see "Next Steps" at the end of this section).

Representative HGL plots for corridors E and F2 under peak delivery (non-bypass) conditions are shown in **Figures 4-8 and 4-9.** Refer to **Table 4-6** for required Richland Chambers and Cedar Creek Intake pumping heads for full capacity pumping.

Bypass Operations

A separate analysis was conducted to evaluate flow transmission in pump station bypass mode. Two cases were evaluated and the primary criterion for evaluating each case was to limit main transmission pipeline operating pressures to approximately 250 psi (even if higher horsepower pumps are required at any given station to accommodate the flow and head under a bypass vs. non-bypass scenario). For case 1, pump station bypass analysis was based on trying to maximize flow from Lake Palestine to Lake Benbrook without additional flow injections along the way. For Case 2, a combination of pumping is used from Cedar Creek and Richland-Chambers to maximize bypass of one of the booster stations (a more commonly anticipated bypass theme). The results for the bypass analyses are also included in **Figure 4-6**.

Hydraulic Profile for Corridor-7B, 2 BPS, Base Pipe Sizes

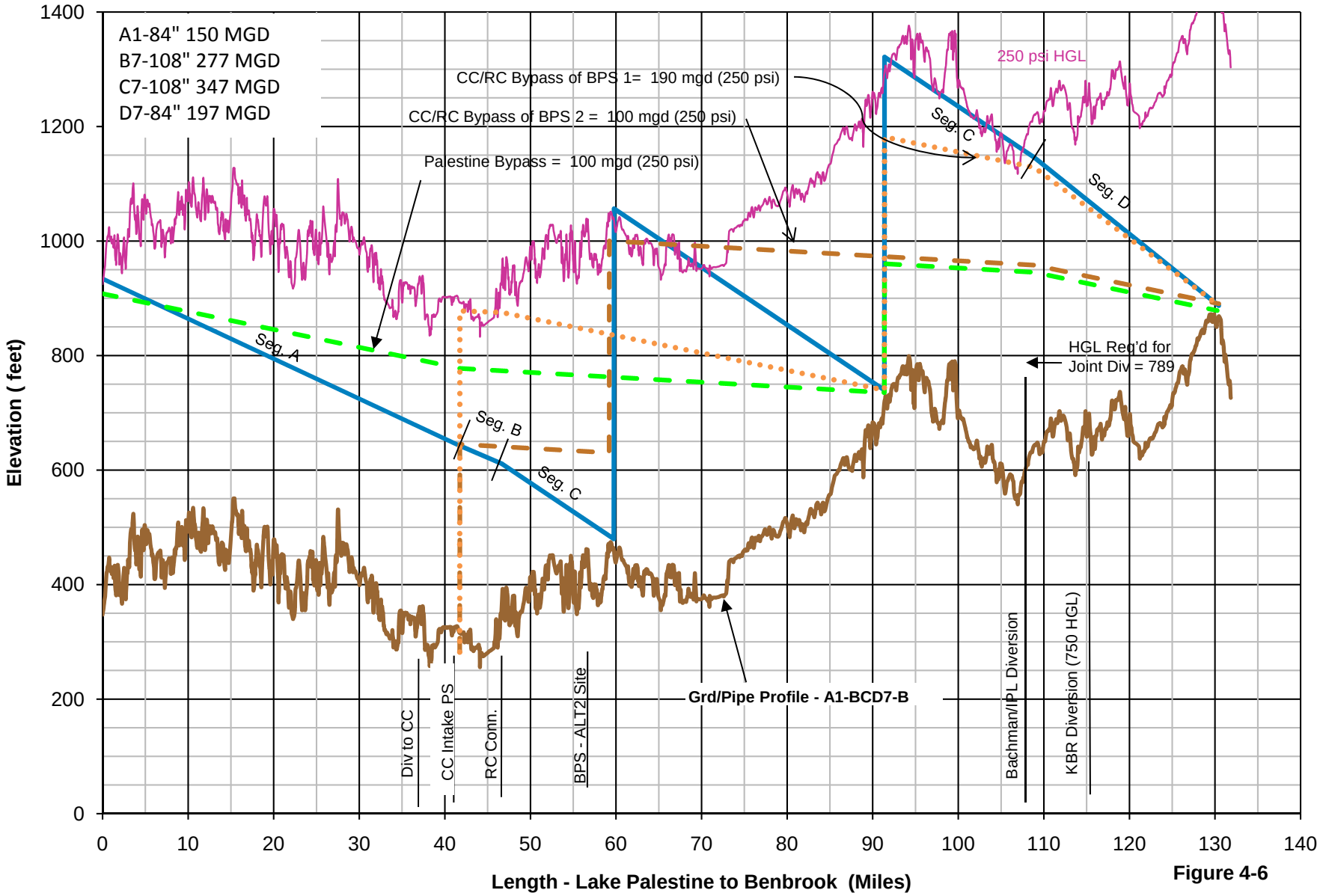

Figure 4-6

Hydraulic Profile for Corridor-7B, 2 BPS, 790 Tunnel, Base Pipe Sizes

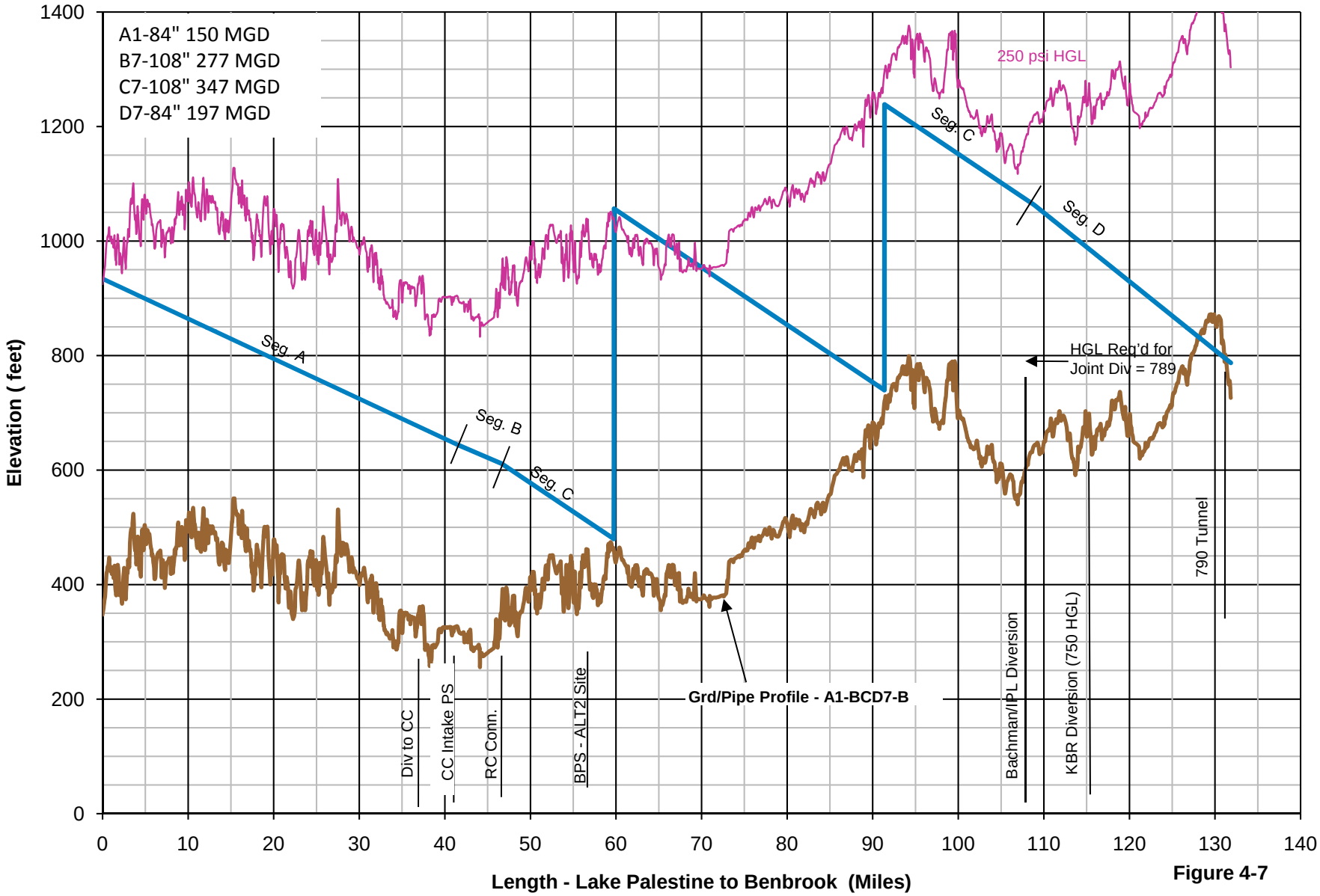

Figure 4-7

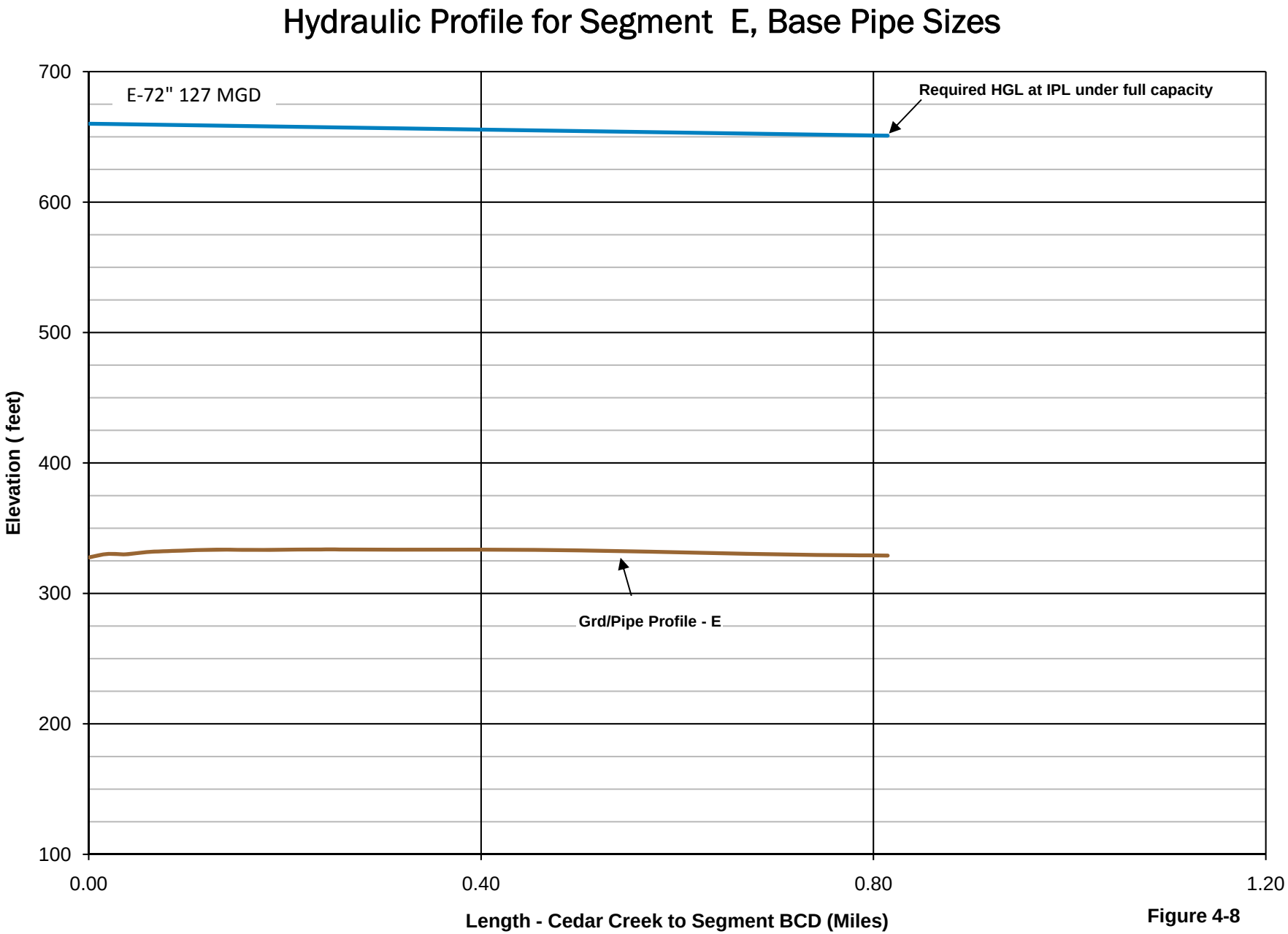
Hydraulic Profile for Segment E, Base Pipe Sizes
E-72" 127 MGD
Required HGL at IPL under full capacity
Grd/Pipe Profile - E
Elevation (feet)
700
600
500
400
300
200
100
0.00
0.40
0.80
1.20
Length - Cedar Creek to Segment BCD (Miles)

Figure 4-8

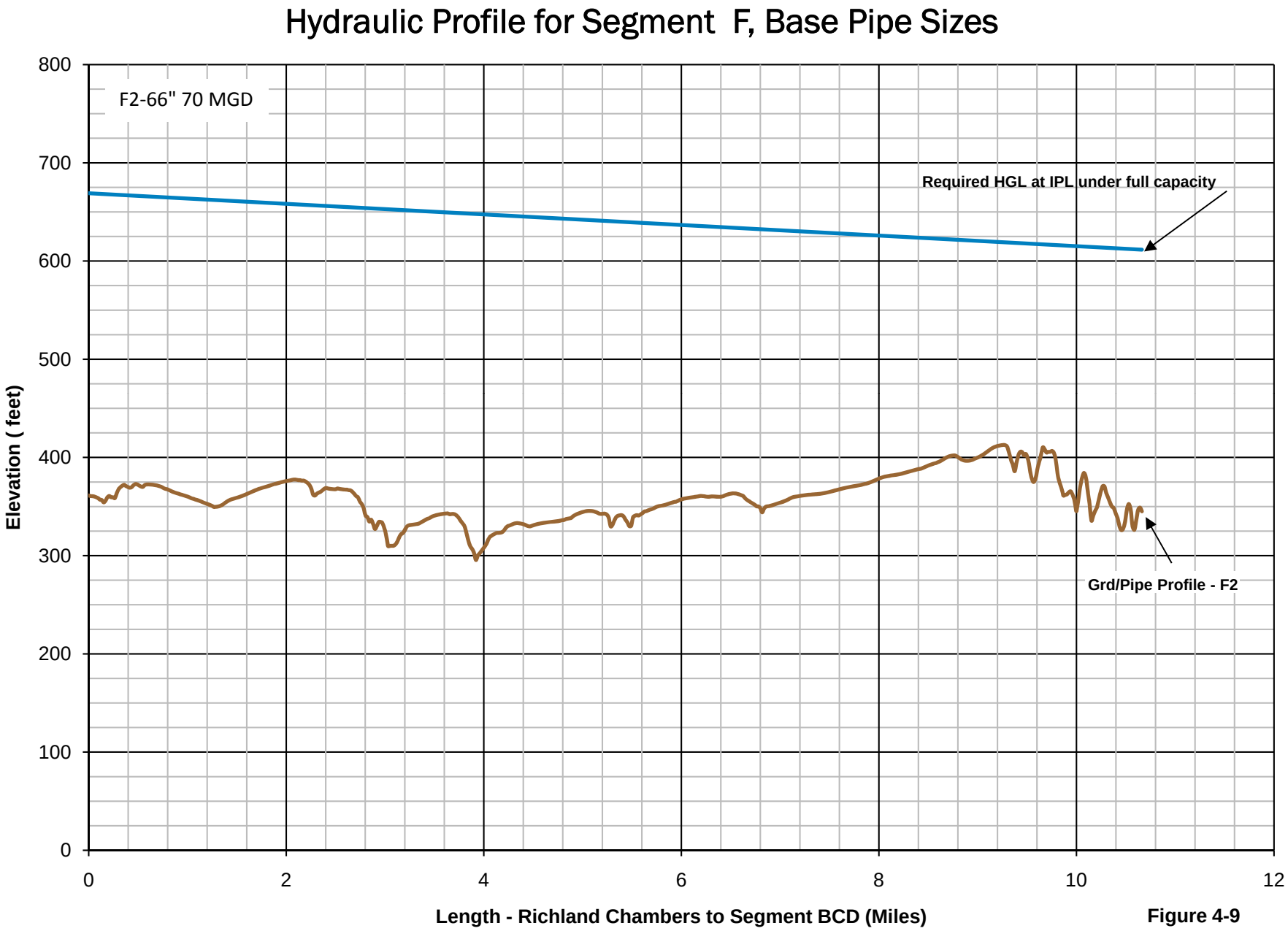
Hydraulic Profile for Segment F, Base Pipe Sizes
F2-66" 70 MGD
Required HGL at IPL under full capacity
Grd/Pipe Profile - F2
Elevation (feet)
800
700
600
500
400
300
200
100
0
0
2
4
6
8
10
12
Length - Richland Chambers to Segment BCD (Miles)

Figure 4-9

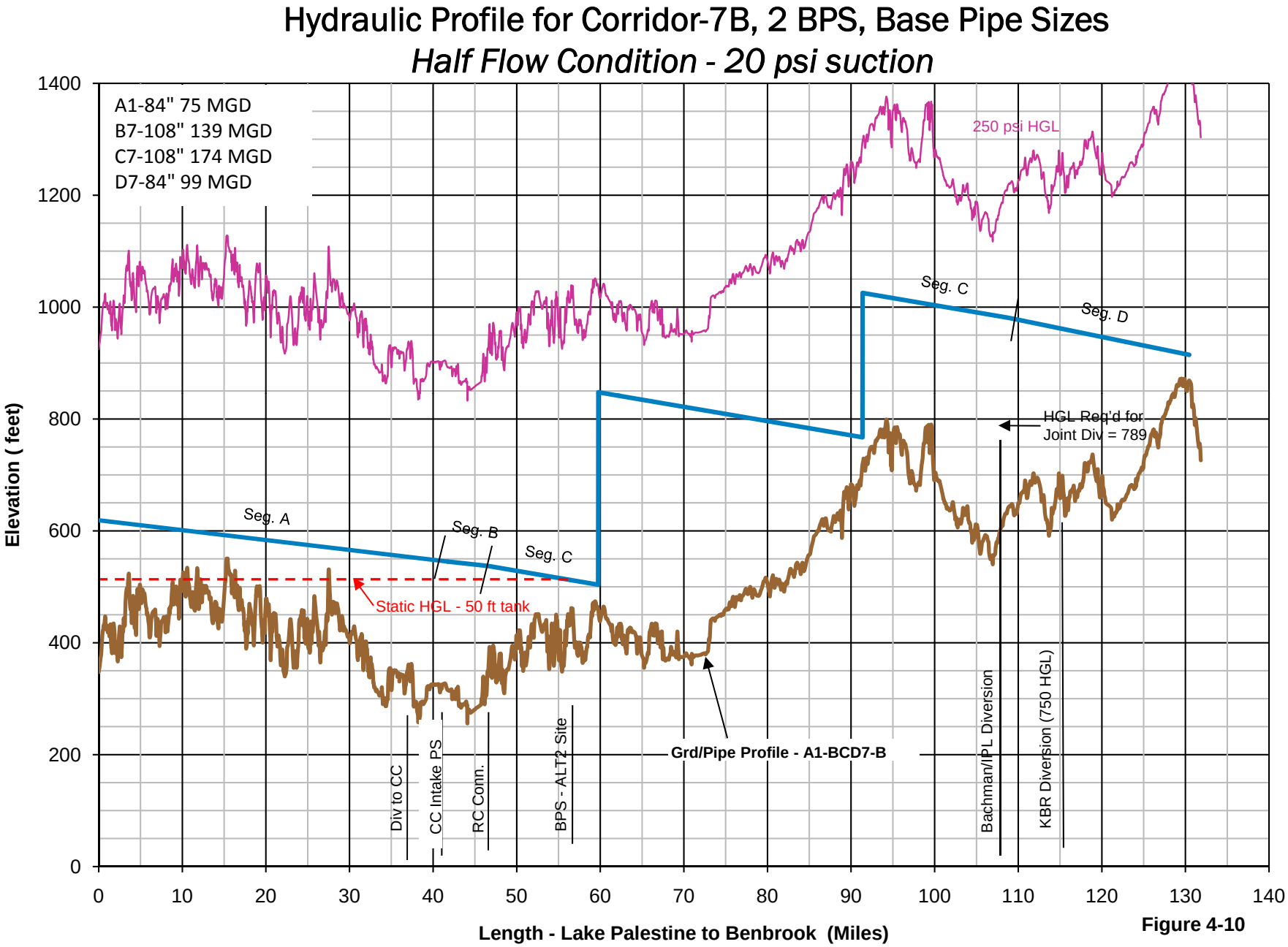
Hydraulic Profile for Corridor-7B, 2 BPS, Base Pipe Sizes
Half Flow Condition - 20 psi suction
A1-84" 75 MGD
B7-108" 139 MGD
C7-108" 174 MGD
D7-84" 99 MGD
250 psi HGL
Seg. A
Seg. B
Seg. C
Seg. C
Seg. D
HGL Req'd for Joint Div = 789
Static HGL - 50 ft tank
Grd/Pipe Profile - A1-BCD7-B
Div to CC
CC Intake PS
RC Conn.
BPS - ALT2 Site
Bachman/IPL Diversion
KBR Diversion (750 HGL)
Elevation (feet)
Length - Lake Palestine to Benbrook (Miles)
0
200
400
600
800
1000
1200
1400
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140

Figure 4-10

Table 4-6. Hydraulic Results with Corridor 7B Reroute

Scenario	Segment	Flow (mgd)	Pipe Size (in)	Velocity (fps)	Head loss (ft/1000 ft)	Pump Station	TDH (ft)	TDH (psi)	Hydraulic Power (HP)
2 BPS - To Benbrook	A1	150	84	6.03	1.29	Pal Intake	624	270	16,428
	B7	277	108	6.74	1.17				
	C7	347	108	8.44	1.84	BPS1	577	250	35,141
		347				BPS2	582	252	35,446
	D6	197	84	7.92	2.23				
	E	127	72	6.95	2.12	CC Intake	378	164	8,426
	F2	70	66	4.56	1.00	RC Intake	396	172	4,865
									100,306
2 BPS - To Benbrook (790 Crowley Tunnel)	A1	150	84	6.03	1.29	Pal Intake	624	270	16,428
	B7	277	108	6.74	1.17				
	C7	347	108	8.44	1.84	BPS1	577	250	35,141
		347				BPS2	499	216	30,391
	D6	197	84	7.92	2.23				
	E	127	72	6.95	2.12	CC Intake	378	164	8,426
	F2	70	66	4.56	1.00	RC Intake	396	172	4,865
									95,251
2 BPS - To Benbrook (1/2 flow)	A1	75	84	3.01	0.32	Pal Intake	309	134	4,068
	B7	138.5	108	3.37	0.29				
	C7	173.5	108	4.22	0.46	BPS1	344	149	10,475
		173.5				BPS2	258	112	7,857
	D6	98.5	84	3.96	0.56				
	E	63.5	72	3.47	0.53	CC Intake	268	116	2,987
	F2	35	66	2.28	0.25	RC Intake	279	121	1,714
									27,100

For case 1, bypass analysis (conveying Lake Palestine water with one booster pump station bypassed) indicates capacity is limited to about 100 mgd. For case 2, either booster station can be bypassed (alternated), although bypass of booster 1 while maintaining operation at booster 2 can achieve greater bypass capacity while keeping the main transmission line operating pressures at or below about 250 psi. This second case requires utilizing the Cedar Creek and/or Richland-Chambers intake pump stations under high head conditions and could result in operating pressures in the E or F segments exceeding 250 psi (proper pipe sizing and optimization of associated flow contributions from each supply reservoir are critical to controlling these branch pressures). To take full advantage of a given bypass configuration, it would be necessary to operate at higher suction pressures at the bypassed station and, as a result, portions of the main transmission pipeline would have to be designed for higher operating pressures.

For case 1, bypass flows are limited to about 100 mgd and Booster Station No.1 is bypassed while Booster Station No. 2 is maintained in operation. For case 2, flows are contributed from both Cedar Creek and Richland-Chambers (no contributory flows from Lake Palestine for this scenario). If Booster Station No. 1 is utilized and Booster Station No. 2 bypassed, flows are limited to about 100 mgd. Since both Cedar Creek and Richland-Chambers lake pumping stations are used to boost up the operating HGL, there is not a significant additional gain in head achieved with the first booster station operating and the second booster station off line, limiting the capacity of this configuration. However, if both of the intake stations are used to boost the HGLs up to the 250 psi limit and the first booster station is bypassed instead, the second booster station can operate much as a true booster pumping application and nearly doubles the delivery capacity over the alternate case 2 configuration (approximately 190 mgd).

Low Flow Pumping Considerations

Figure 4-10 depicts the operating HGL under half flow conditions (with the configuration discharging to a balancing reservoir at Crowley). Each supply reservoir is delivering half the flow shown in Figures 4-6 and 4-7. The represented flow condition approximately represents a transition point from multiple booster pumping operation to bypass and single booster operation (generally the same flow delivered to the Benbrook area for case 1 bypass, but considerably less than case 2 bypass with Booster Station No. 1 out of service).

Under lower flow rates from Lake Palestine (below 75 mgd), there may be need for a balancing reservoir near the highpoint in Segment A to maintain the HGL above the ground surface while conserving head at Booster Station No. 1. Alternatively, the balancing reservoir could serve also as the suction supply to Booster Station No. 1 (remote forebay) to avoid this concern. However, the same reservoir would need to be bypassed under high flow conditions out of Lake Palestine (defeating this advantage). The overall need/benefit for this reservoir may depend mostly on the anticipated mode of operations. Current operations planning indicate that withdrawals from Lake Palestine are rarely anticipated to drop below 75 mgd or the system will go into bypass mode at these lower flows. Therefore, at this time there appears to be little justification for a balancing reservoir near the highpoint in Segment A (approximately 550 ft msl).

Another potential concern is draining of raw water supply from the highpoints along segment A into the suction supply tank or reservoir at Booster Station No. 1 after routine shut down of the Segment A pipeline and Lake Palestine Intake pump station. The line would only drain for those portions of the Segment A line installed at a higher elevation than the overflow of the booster

station supply tank (limited volume). There are several ways to solve this problem for either Booster Station site. Options include an automated valve to isolate the line ahead of the supply tank/reservoir, installation of a stand pipe with sufficient height (and isolation from the supply tank/reservoir), construction of a tank or reservoir with sufficient volume to receive the excess volume in the Segment A pipeline (easier to accommodate with a reservoir). Operational issues can be further explored during conceptual design, but should not present an issue for selection of either site for Booster Station No. 1.

Table 4-6 shows hydraulic power (no pump or electrical efficiency losses included) used for the half flow condition along with that for the full capacity conditions (with and without the tunnel under Benbrook highpoint).

4.3 Hydraulic Evaluation Criteria Matrix

In order to provide a comprehensive and consistent basis for comparing corridor alternatives for hydraulic performance, evaluation criteria were developed as shown in **Table 4-7**. For consistency, the scoring for corridors 1 and 5 (hybrid of both recommended in Report No. 2) is compared with corridor 7. Each evaluation criteria is designated either quantitative or qualitative. Quantitative criteria are scored on a number and qualitative criteria are scored on a scale of 'poor-fair-good-better-best'. The results in the table are generally based on evaluation under peak flows conditions.

4.4 Hydraulic Performance Summary

Updated findings and observations are summarized within specific categories below:

- The updated IPL configuration for corridor 7 is not substantially different in hydraulic performance from the previous corridor 1-5 performance. Net head requirements are generally equal when comparing the two corridors. Construction of a tunnel under the Benbrook high point (Crowley tunnel), would result in an average static head pump savings of 80 feet under virtually all delivery scenarios to the Lake Benbrook area. However, additional pumping to the Benbrook booster and for delivery to Rolling Hills water treatment plant may be necessary with this configuration. If, ultimately, the tunnel configurations at Crowley and Midlothian prove to be preferable, the corridor alignment should be altered somewhat to take full advantage of shortened length and lowered highpoints (See Section 2 for more discussion).
- Many bypass operating scenarios are possible and these have been examined further than in previous studies. While full bypass based on delivery of Lake Palestine (only) is limited to about 100 mgd, bypass pumping from Cedar Creek or Richland Chambers Reservoirs (or a combination) can take advantage of the ability to bypass either booster station. However, bypass of Booster Station No.1 and operation of Booster Station No. 2 has higher delivery potential (up to 190 mgd) over the alternate booster bypass configuration. Higher operating heads than under full capacity system delivery with both booster stations operating would be necessary from the intake pumping stations to take full advantage of this; portions of the intake delivery piping (segments E and F) as well as the main line IPL would have to be of higher pressure class as well.

Table 4-7. Hydraulic Evaluation Criteria Matrix - Main Corridors

Evaluation Criteria	Unit	2 Booster Stations		
		1	5	7
Hydraulics				
Minimize overall pumping (Peak Flow)	HP	100,879	98,030	100,306
Minimize RC and CC Pumping (Peak Flow)	HP	11,093	13,686	13,291
Diversion to Bachman w/o supplemental pumping	Yes/No	Yes	Yes	Yes
Ease of Operations	---	Best	Better	Good
Number of redundant power supply sources	#	2	2	2
Risk of total system shutdown	---	Best	Better	Better
Bypass capabilities (A through D)	Flow (mgd)	110	110	100
Delivery to Customers	---	Poor	Better	Fair
Maximize Storage (Bal R)	---	Good	Good	Good
Surge	---	Fair	Fair	Fair

- Preliminary pump selection screening has been completed for the booster pump stations as part of the design standardization process (being conducted by the IPL Conceptual Design Team) which indicates that high efficiency, high capacity/head units are available from multiple manufacturers. Preliminary evaluation also shows that these selections can be optimized to provide some additional run out while maintaining high mechanical efficiencies under potential variable (reduced) speed operations. Additional evaluation under numerous potential operating scenarios will be necessary during conceptual and final design phases to optimize final pump selection and configuration.

4.5 Next Steps

The tasks listed below will expand the hydraulic analysis during the Conceptual Design phase of the project. Much of the optimization modeling during this phase will be conducted using a fully integrated hydraulic network model which can take advantage of connectivity and simulation of the IPL with the existing transmission system.

- Develop hydraulic design basis for pipelines, appurtenances, outlet structures, connections, and terminal storage reservoirs. Also assess the impact of pipeline aging on loss of capacity.
- Use hydraulic and life-cycle cost analysis to further refine selection of lowest cost pipeline size for each segment of the IPL.

- Use hydraulic and life-cycle cost analysis to further refine selection of preferred pump station configuration (number of booster pump stations). Consider 2 or 3 booster pump station options.
- Further development of primary high capacity and bypass pumping potential for a range of pumping configurations and facility optimizations. Comparisons will be performed for bypass pumping associated with open cut pipeline vs. tunnels at Midlothian and Crowley with further life-cycle cost comparisons.
- Compare pumping from the Lake Benbrook area to the east towards the City of Ennis for open-cut and tunnel options at Midlothian and Crowley in terms of feasibility and flow volumes.
- Further refinement of hydraulic terminations at Longhorn Park to better characterize the recommended configuration including delivery to the Benbrook booster versus termination at the TRWD dechlorination facility.
- Hydraulic support analysis for evaluation of infrastructure phasing plans to ensure adequate delivery while optimizing deferment and capital investment of the IPL over time.
- Evaluate hydraulic delivery of flows from East Texas to Kennedale Balancing Reservoir (through Segment I) without delivery to Benbrook Lake through the IPL.
- Calculate the pressure and flow potential at interconnects to the existing TRWD system at the crossing of the Richland Chambers pipeline (TRWD segment 5) and the intersection of segment G.

Section 5
Costs

This section describes the project cost analysis and the current basis for the conceptual level opinion of probable capital cost and life cycle cost for the Integrated Pipeline route selection phase. Additional cost estimates will be generated and updated at project milestones such as conceptual, preliminary, and final design, each with greater detail so that estimates improve as project definition improves.

This section first describes parameters used in the cost analysis and its methodology. Next, capital cost estimates are summarized for each segment of the pipeline route and for each facility, followed by a life-cycle cost estimate of the recommended route. Detailed cost spreadsheets are included in Appendix F of this report.

The detailed cost spreadsheets and tables noted in this report have been validated by the 0% Value Engineering (VE) team. Most of the recommendations and cost estimating methodology suggestions were adopted and incorporated into this final report subsequent to the VE workshops held during the week of May 17, 2010. However, because some analyses were completed prior to the VE, many comparative cost estimates rely on older methodology. This is most evident in the appendices, which contain results from analyses completed prior to the VE. The costs in those sections will therefore not match the results in the main body of the report.

Because Dallas is reviewing multiple alternatives to bring water into their system from the IPL, this report does not analyze costs for connection between the IPL and Dallas' delivery point. Costs for many options are included in the Dallas Delivery Location Analysis Technical Memoranda and will be added to these overall project costs after a delivery point and path has been selected. The overall IPL capital cost estimate including the Dallas Delivery option selected in *Amendments 3 and 4 of Phase 1 of the Raw Water Transmission System Integration Study, Report No. 2* is located in Appendix M of this report. **Figure 5-1** identifies the IPL segments and facilities for which costs were developed in this report.

5.1 Cost Parameters and Methodology

Cost opinions were prepared using spreadsheet models. The expected accuracy range, degree of preparation effort, typical estimating method and level of project definition were typical of a conceptual level Class 4 estimate (using AACE International Recommended Practice No. 17R-97 - Cost Estimate Classification System) based on primarily stochastic methods. The cost parameters were based on recent bid tabs from several large diameter pipeline and pump station projects constructed in the Dallas/Fort Worth area and local manufacturers' pipeline unit cost data.

For purposes of this cost analysis, the pipeline was divided into various pipeline segments based upon the potential ownership and cost allocations between TRWD and DWU. **Table 5-1** lists the various pipeline segments and design flow rates.

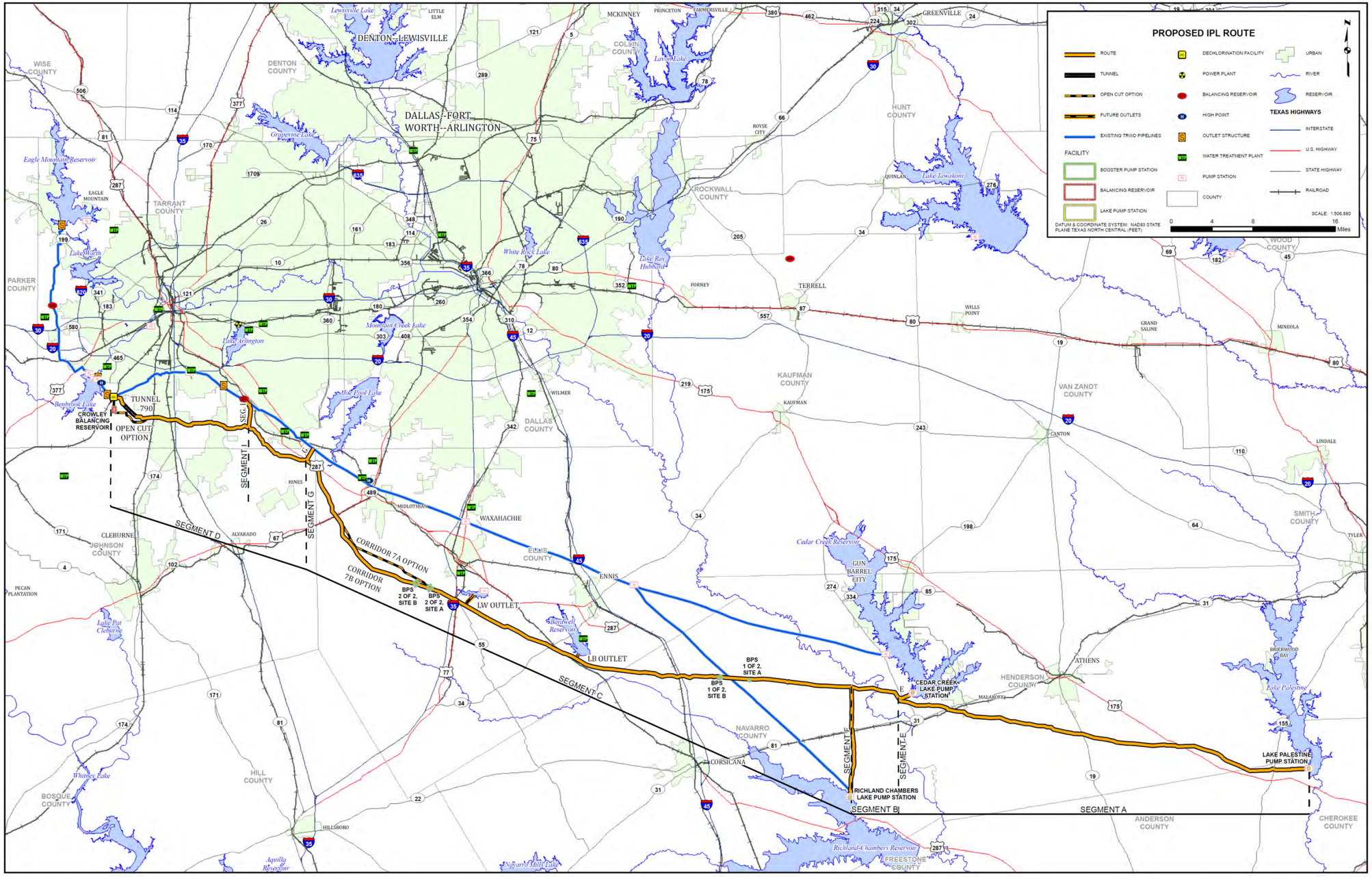

Figure 5-1 Integrated Pipeline Route

Table 5-1. Segment Descriptions

Segment	From	To	Design Flow (MGD)
A	Lake Palestine	Cedar Creek Connection	150
B	Cedar Creek Connection	Richland-Chambers Connection	277
C	Richland-Chambers Connection	Bachman Take-off Point	347
D	Bachman Take-off Point	Connection to Benbrook Pipeline	197
E	Cedar Creek Reservoir	Connection to the Main Proposed Pipeline	127
F	Richland Chambers	Connection to the Main Proposed Pipeline	70
G	Main Proposed Pipeline	Existing TRWD Lines	347
I	Main Proposed Pipeline	Kennedale Balancing Reservoir	197

5.1.1 Energy Cost Calculation Methodology

The energy costs for the transmission of flows through the Integrated Pipeline were determined using the IPL system simulation model (to generate flow time series) and TRWD's 'tariff spreadsheet' (to calculate energy usage and cost). The baseline integrated operating conditions of TRWD and Dallas sub-systems were defined and modeled using the STELLA program and are described in *Amendments 3 and 4 of the Raw Water Transmission System Integration Study, Report No. 1* (see Section 2 of that report). The STELLA model (the system simulation model) was used to calculate the flows transferred from Cedar Creek and Richland-Chambers Reservoirs (TRWD supply sources) and Lake Palestine (Dallas's supply source) through the three transmission pipelines (TRWD's existing CC and RC pipelines and the proposed integrated pipeline). As described in Report No. 1, model simulations were performed assuming no water sharing between TRWD and Dallas, using the hydrologic period-of-record extending from 1941-1986, and using demands representing the projected demand for each decade from 2010 to 2060.

TRWD currently uses a spreadsheet model to determine the energy costs incurred for pumping operations in their existing system. Because TRWD will control integrated system operations, this same model was used in this analysis. Few modifications were made to the spreadsheet model representing current system operations and to incorporate the Integrated Pipeline and the 3-booster and 2-booster pump stations modes of pumping operations. The flows generated by the system simulation model (STELLA) for each decade are put into the spreadsheet model, which then distributes the flows between the three pipelines based on pipeline hydraulics and the optimum flow distribution ratio that results in lowest energy costs for the entire system (existing TRWD pipelines and proposed IPL). Once the flows are distributed, the total dynamic head (TDH) and kilowatts (KW) required to transmit those flows through each pipeline segment between the pump stations are computed.

The total energy cost incurred by TRWD's system operations is comprised of generation costs (this is the cost required to move X amount of kWh through the system) and transmission and distribution costs. The generation costs are computed by multiplying the total kWh required for flow transmission with the costs/kWh factors developed and described in Appendix 5-C of *Amendments 3 and 4 of Phase 1 of the Raw Water Transmission System Integration Study* -

Report No. 1. The generation cost/kWh factors presented in that report were increased by $0.02 to make the generation costs/kWh factors comparable to TRWD's current contracted rates with the electricity providers. The transmission and distribution costs were computed using different distribution cost factors provided by TRWD.

The energy costs for intermediate years between each decade were linearly interpolated from the costs calculated at each decadal demand level. Because determination of the pipeline route was running on a parallel track to all of this cost estimating, it was not possible to determine which electricity provider would be supply to the pump stations. For this analysis, rates were based on current TRWD electricity providers.

The energy costs for different combinations of pipeline routes and pumping options are presented in Appendix A of this report. Demand projections on which these operating costs are based are presented in **Tables 5-2 and 5-3**. Demand values are based on TRWD estimates (using customer input) and Dallas's 2005 Long Range Water Supply Plan Update. Monthly adjustment factors and climate adjustment factors were applied, per direction from TRWD (same as RiverWare input) and Dallas.

Table 5-2. Demand Values (mgd) used for TRWD Customer Demand Nodes

	2010	***2020***	***2030***	***2040***	***2050***	***2060***
Holly WTP	48	50	47	43	39	35
Eagle Mountain WTP	50	65	80	95	110	127
JFK WTP	39	46	49	56	62	69
Pierce Burch WTP	38	38	47	53	59	66
Mansfield WTP	9	13	17	21	25	28
TRA Mosier Valley	38	48	59	69	80	90
Benbrook Local Use	3	4	6	7	8	9
Worth Local Use	4	4	4	4	4	4
Eagle Mountain Local use	2	2	3	3	4	4
Bridgeport Local Use	6	6	8	8	9	10
Arlington Local Use	2	2	2	3	3	3
Richland Chambers Local Use	3	4	4	5	5	5
Cedar Creek Local Use	4	4	5	6	7	8
Northwest WTP	10	13	21	30	41	53
Weatherford	4	4	4	4	4	4
BWSA	2	2	2	2	2	2
SW WTP	0	10	12	15	17	20
Rolling Hills WTP (removed SW WTP)	77	76	81	89	98	106
Ellis County Aggregated (Total Proposed Projections)	49	58	58	58	58	58
Total TRWD Demands	386	446	508	569	634	702

Table 5-3. Demand Values (mgd) used for Dallas Demand Nodes

Westside Lake Level Trigger	When Lewisville is above 520 ft						When Lewisville is below 520 ft					
Decade	2010	2020	2030	2040	2050	2060	2010	2020	2030	2040	2050	2060
Total Dallas Treated Water Demand	501	575	614	637	651	666	501	575	614	637	651	666
Westside System Demand [1, 3]	301	345	368	382	390	399	261	299	319	331	338	346
Elm Fork WTP [2]	195	224	239	249	254	260	169	194	207	215	220	225
Bachman WTP [2]	105	121	129	134	137	140	91	105	112	116	118	121
Eastside System Demand [1 3]	200	230	245	255	260	266	240	276	295	306	312	320
Eastside WTP	200	230	245	255	260	266	240	276	295	306	312	320
Westside System Raw Water Demand [4]	33	51	63	74	86	97	33	32	71	104	140	169
Eastside System Raw Water Demand [4]	3	3	3	3	3	3	3	3	3	3	3	3
Potential Customers [5]	2	2	2	3	3	4	2	2	2	3	3	4
Total Demand (including 5% treatment losses)	566	662	716	752	780	808	566	643	724	784	837	883

[1]Total Dallas Demand is distributed between Westside and Eastside systems in the ratio of 60:40 (When Lewisville >518 ft) and 52:48 (When Lewisville < 518 ft).

[2]Total Westside Demand is distributed between Elm Fork and Bachman WTP in the ratio of 65:35.

[3] Total Demand for each system (Westside and Eastside) is a total of Treated Water Demand, Raw Water Demand, and Demand for Potential Customers.

[4] Raw Water Demands are the demands supplied from Dallas system to other entities.

[5] Demand attributed to potential future demands for customer cities. Potential Demands are equally allocated to Eastside and Westside systems.

5.1.2 Capital Costs Calculation Methodology

Pipeline Costs

Pipeline costs are the most significant component of the overall IPL project estimate. Local pipeline manufacturers were consulted for budget estimates. Some of the assumptions used in the pipeline cost analysis include:

- Steel: Steel pipe will be manufactured and tested in accordance with AWWA C200. Steel grades of 36,000 psi, 42,000 psi, and 48,000 psi were utilized in determining the manufacture's pipeline unit cost estimate.
- Interior Lining: Pipeline will be cement mortar lined.
- Exterior Coating: Buried pipe will be polyurethane coated.
- Lengths: Standard lengths are 50 ft for steel.

Pipeline pressure classes were chosen based on the hydraulic grade lines developed for each pipeline segment as described in Section 4 of this report. **Figure 5-2** is an example of an HGL plot also showing pipe pressure class. Pipeline installation (excavation, bedding and backfill, appurtenances, etc.) costs were developed using recent data from large diameter pipeline installation projects constructed in the Dallas/Fort Worth and east Texas areas.

An itemized list of construction materials and labor used to generate the capital cost estimate is located in Appendix F of this report. **Table 5-4** shows steel pipe unit costs used in this analysis.

Table 5-4. Steel Pipe 2009 Material Unit Costs/Pressure Class

Pipe Diameter (inches)	Unit Cost (CL 150)	Unit Cost (CL 175)	Unit Cost (CL 200)	Unit Cost (CL 225)	Unit Cost (CL 250)
60	$189	$189	$189	$212	$236
66	$223	$223	$223	$250	$279
72	$259	$259	$259	$292	$324
78	$296	$296	$296	$334	$371
84	$339	$339	$344	$382	$425
90	$370	$370	$375	$417	$464
96	$410	$410	$415	$462	$513
102	$456	$456	$456	$513	$569
108	$510	$510	$510	$573	$637
120	$622	$627	$627	$705	$783

Pump Station Costs

Pump Station pricing was developed from bid tabs of similar size projects with similar pump and piping configurations (comparable type, size and number of pumps). Costs for pumps, motors, and drives were estimated based on current pricing provided by manufactures. Costs for pump suction and discharge piping (including headers and yard piping) and valves were estimated using bid tabs from past DWU and TRWD projects.

The use of horizontal split-case pumps was assumed at all booster pump stations. It was also assumed that all pumps at booster pump stations will be equipped with variable frequency drives (VFDs). Horizontal split-case pumps were assumed to be between 20,000 GPM to 30,000 GPM each (approximate pump suction and discharge size = 42” x 36”). For the purpose of estimating, the pump configuration was assumed to be four (4) units for firm capacity plus one (1) backup. Vertical turbine pumps were assumed at all lake intake pump stations, each equipped with a VFD. Vertical turbine pump sizes were assumed to be between 30,000 GPM to 40,000 GPM each. For the purpose of estimating, the pump configuration was assumed to be eight (8) units for firm capacity plus one (1) backup. An itemized list of construction materials and labor used to generate the capital cost estimate is located in Appendix F of this report.

Easement and Real Estate Costs

The easements and property costs were determined based on acquisition costs from recent Dallas Water Utilities and Tarrant Regional Water District large diameter pipeline projects. A 150 ft permanent easement width was assumed to accommodate a future second (and perhaps third) pipeline within the same right-of-way. The acquisition of the pump station sites were also included in the overall cost estimate.

5.1.3 Life Cycle Costs Calculation Methodology

In calculating the lifecycle cost, a 100-year project life was assumed, spanning from 2018 (project commissioning) through 2117, and annual costs were broken down into four categories: debt service, operations and maintenance, energy, and renewal and replacement.

Debt Service

Debt service represents the cost associated with the expected debt financing to pay for the capital costs of each project. For this project, the Dallas and TRWD costs of debt, 4.88% and 5.07%, respectively, were averaged together to yield 4.97%. These costs of debt were then applied to the capital cost of the appropriate scenario and a payment schedule was generated for a 30-year, fixed rate, level payment debt issue.

Operations and Maintenance

The operations and maintenance expenses (O&M) for each scenario were calculated based on historical itemized operation and maintenance information from Dallas Water Utilities.

Table 5-5. Pipeline O&M (not including energy)

Item	First year	Cost/ #year
Project Vehicles - 2 - 4x4 vehicles to drive ROW	$70,000	$0
Gas - Project Vehicles	$7,000	$3,500
Maintenance - Project Vehicles	$2,000	$2,000
ROW maintenance - mowing, clearing, etc.	$236,000	$236,000
CP - Annual Survey - 3 people 1 month	20,000	$20,000
Chemical Feed System	$5,400,000	$5,400,000
Valve Maintenance and replacement	0	$45,000
Labor - 2 people full time @ $34/hour including benefits	$141,000	$141,000

Assumptions:

1. Replace vehicles every 5 years
2. Assume 20k mileage per year @ 18 miles/gal. $3/gal gas
3. Assume tire replacement and fluid changes per year.
4. Mowing and clearing 130 miles of 150-foot wide pipeline ROW @ $100/acre. Mow once per year
5. Assume 3 people for annual survey, test station maintenance, and rectifier maintenance.
6. Based on 350 MGD @ $0.0426/1000 gal. Includes caustic, Chlorine, LAS, Power, Maintenance
7. Assume replacement of 0.5% of total valves per year - 130 miles of pipeline with a valve every 1500-feet.
8. Assume 2 people dedicated to pipeline O&M

Table 5-6. Pump Station O& M

Item	First Year	Cost/ #year
Pump Room HVAC Power	$100,000	$100,000
Pump Room Lighting Power	$10,000	$10,000
Pump Station Operator	$125,000	$125,000
Pump Station general maintenance employee	$80,000	$80,000
Yard and & Landscaping	$5,000	$5,000
Security Service	$100,000	$100,000
Pump Rebuild Maintenance (10-yr cycle)/pump	$15,000	$15,000
Roof Maintenance	$0	$30,000
Painting	$0	$15,000
Intake Screens	$3,000	$3,000
Motor Cooling System Maintenance	$3,000	$3,000
Bridge Crane Maintenance	$3,000	$3,000

Assumptions per pump station:

1. Including fringe benefits
2. Onsite guard service
3. Add cost every 10 years
4. Replace every 30 years
5. Repaint every 5 years

5.2 Cost Analysis Results

Based on the parameters and methodology described in Section 5.1, the following capital and life-cycle cost estimates were generated. **Table 5-7** summarizes the capital cost for the Integrated Pipeline route and facilities recommended in this report. **Table 5-8** contains energy cost estimates for each decade of operations based on the baseline operating conditions developed during this study. The full Operations Study that will be completed in the next phase of this IPL Project will define operating conditions more specifically and refine these operating costs. Using the values in Tables 5-7 and 5-8, the present worth of the 100-year life-cycle cost is **$3,053,000,000.**

Table 5-7 IPL Capital Costs

COST ESTIMATE SUMMARY | **SCENARIO** VE validated w/o Dallas Delivery

2009 Prices	***INTEGRATED PIPELINE PROJECT***	Date: 6/25/2010

Item		Estimated Costs for Facilities
Capital Costs		
Pipelines		
Segment A - Lake Palestine to Cedar Creek Reservoir	$	222,556,000
Segment B - Cedar Creek to Richland-Chambers Tie-in	$	43,597,000
Segment C - Richland-Chambers Tie-in to Segment G Connection	$	514,880,000
Segment D - Seg G Connection to Lake Benbrook	$	181,894,000
Segment E - Cedar Creek to Main Trunkline	$	8,040,000
Segment F - Richland-Chambers to Main Trunkline	$	45,388,000
Segment G - Main Trunkline to Existing TRWD Pipelines	$	11,790,000
Segment I - KBR Cross Connection	$	19,363,000
Pipelines Subtotal	$	1,047,508,000
Land Acquisition		
Segment A	$	34,811,000
Segment BCDE	$	83,482,000
Segment F	$	5,990,000
Segment G	$	1,505,000
Segment I	$	3,070,000
Land Subtotal	$	128,858,000
Pump Stations		
Lake Palestine Intake and PS		$51,627,000
Richland-Chambers Lake PS		$23,980,000
Cedar Creek Intake and PS		$47,285,000
Booster PS 1		$68,989,000
Booster PS 2		$68,989,000
Pump Stations Subtotal	$	260,870,000
Power Supply	$	30,000,000
Total Project Capital Cost	**$**	**1,467,236,000**
Escalation @ 3% to mid point of construction (2015)	**$**	**1,700,910,000**

CDM

Table 5-8 Energy Costs per Decade

IPL - Energy Costs Per Decade					
2010	2020	2030	2040	2050	2060
$21,106,000	$25,661,000	$39,091,000	$57,931,000	$79,921,000	$100,099,500

5.3 Integrated vs. Independent Project Development

From the beginning of this project, the Raw Water Transmission System Integration Study which later became known as the Integrated Pipeline Project, the question we sought to answer was: Should TRWD and DWU develop two independent water transmission projects or one integrated water transmission project? The technical aspects of this question were answered in previous reports and a definitive conclusion was reached that 'yes', integration should proceed. This decision rested in large part on the potential cost savings to both TRWD and Dallas in developing a joint project as opposed to two independent raw water conveyance systems.

Cost estimating methods and detail have continued to improve and project definition has improved. At this final stage of planning, it is prudent to again calculate the project cost for the TRWD and Dallas independent project development alternatives and compare them to the IPL configuration. **Table 5-9** contains the results of that comparison. It shows that **significant cost savings will be realized by developing an integrated raw water transmission system as compared to developing independent systems, savings in the range of $375 to $443 million in capital cost and roughly $1 to $1.5 billion in present worth 50-year life-cycle cost.**

Tabel 5-9 Integrated vs Independent Comparisons

COST ESTIMATE SUMMARY		SCENARIO	Comparison of Integrated and Baseline Alternatives

2009 Prices	*Integrated vs Independent*	Date:6/27/10

Parameter	Project Alternative			
	TRWD-Dallas Integrated Pipeline	***TRWD Independent Pipeline***	***Dallas Independent Pipeline - Pal to SE WTP***	***Dallas Independent Pipeline - Pal to Bachman WTP***
Pipeline Segments Included	A through I	B, C, D, E, F	A	A, B, C, G, H
Total Pipeline Length	933,808	522,322	466,021	717,859
Tunnel Length (i.e. deep tunnels, not crossings)	8,480	8,480	0	0
Pipeline Diameter	Segment A-84"; B-108"; C-108", D-84", E-72", F-66", G-108", H-84", I-84"	Segment B-72"; C-90"; D-90", E-72", F-66"	Segment A-84"	Segment A-84"; B-84"; C-90", G-84", H-84"
Number of Booster Pump Stations	2	2	2	2
Number of Intakes and Intake Pump Stations	3 PS, 2 new intakes	2 PS, 1 new intake	1 intake and PS	1 intake and PS
Design Flow	Segment A-150, B-277, C-347; D-197; E-127; F-70; G-197; H-150; I-197	B, E-127; C, D-197; F-70	All - 150	All - 150
Route	Follows Corridor 1/7 as finalized on xx/xx/2010. Runs between CC/RC, south of Lakes Bardwell and Wax., etc……	Follows same route as Integrated Pipeline alternative	-----	-----
Total Land Acquired (acres)	2681	1799	1605	2473
Number of Storage Facilities	1	1	1	1
Total Capital Cost (2009 $)	**$1,726,561,000**	**$977,845,000**	**$1,123,265,000**	**$1,192,079,000**
Energy Usage and Cost: 2010	$21,106,000	$18,709,000	$6,083,000	$8,216,000
Energy Usage and Cost: 2020	$25,661,000	$30,306,000	$10,701,000	$14,455,000
Energy Usage and Cost: 2030	$39,091,000	$46,594,000	$14,506,000	$19,596,000
Energy Usage and Cost: 2040	$57,931,000	$64,653,000	$18,218,000	$24,610,000
Energy Usage and Cost: 2050	$79,921,000	$82,450,000	$22,469,000	$30,351,000
Energy Usage and Cost: 2060	$100,100,000	$96,461,000	*$26,063,000*	$35,206,000
50-year Life-cycle Cost Present Worth	**$2,926,430,000**	**$2,170,296,000**	**$1,762,727,000**	**$1,917,380,000**

Section 6
Recommendations

This report section is meant to provide summary information about the recommended pipeline route in a tabular format. In the sections below are tables that describe the configuration of the recommended route.

In report Section 2, the configuration of the recommended Integrated Pipeline Project (IPL) route was described in specific detail. The IPL is divided into 8 parts that describe Segments A through I. The overall system configuration is shown in **Figure 6-1**. Detailed hydraulic analysis and cost estimating helped develop the optimum pipeline diameters for the IPL project. As a result of the analysis, there is a recommended deep tunnel in Segment D near Crowley. This tunnel is approximately 8,500 feet in length and has both hydraulic and social benefits to the project. This recommendation will also be refined and verified during the Conceptual Design and Operations Study phase. The recommended configuration of the pipeline is noted in **Table 6.1**.

Table 6-1. IPL Configuration

Segment	From	To	Pipeline Diameter	Flow Rate (MGD)	Pipeline Length
A	Lake Palestine	Cedar Creek Connection	84”	150	220,394’
B	Cedar Creek Connection	Richland-Chambers Connection	108”	277	26,159’
C	Richland-Chambers Connection	Bachman Take-off Point	108”	347	329,388’
D	Bachman Take-off Point	Connection to Benbrook Pipeline	84”	197	114,131’
E	Cedar Creek Reservoir	Connection to the Main Pipeline	72”	127	8,517’
F	Richland-Chambers	Connection to the Main Pipeline	66”	70	57,768’
G	Main Pipeline	Existing TRWD Lines	108”	347	7,120’
I	KBR Take-off Point from Main Pipeline	Kennedale Balancing Reservoir	84”	197	14,765’

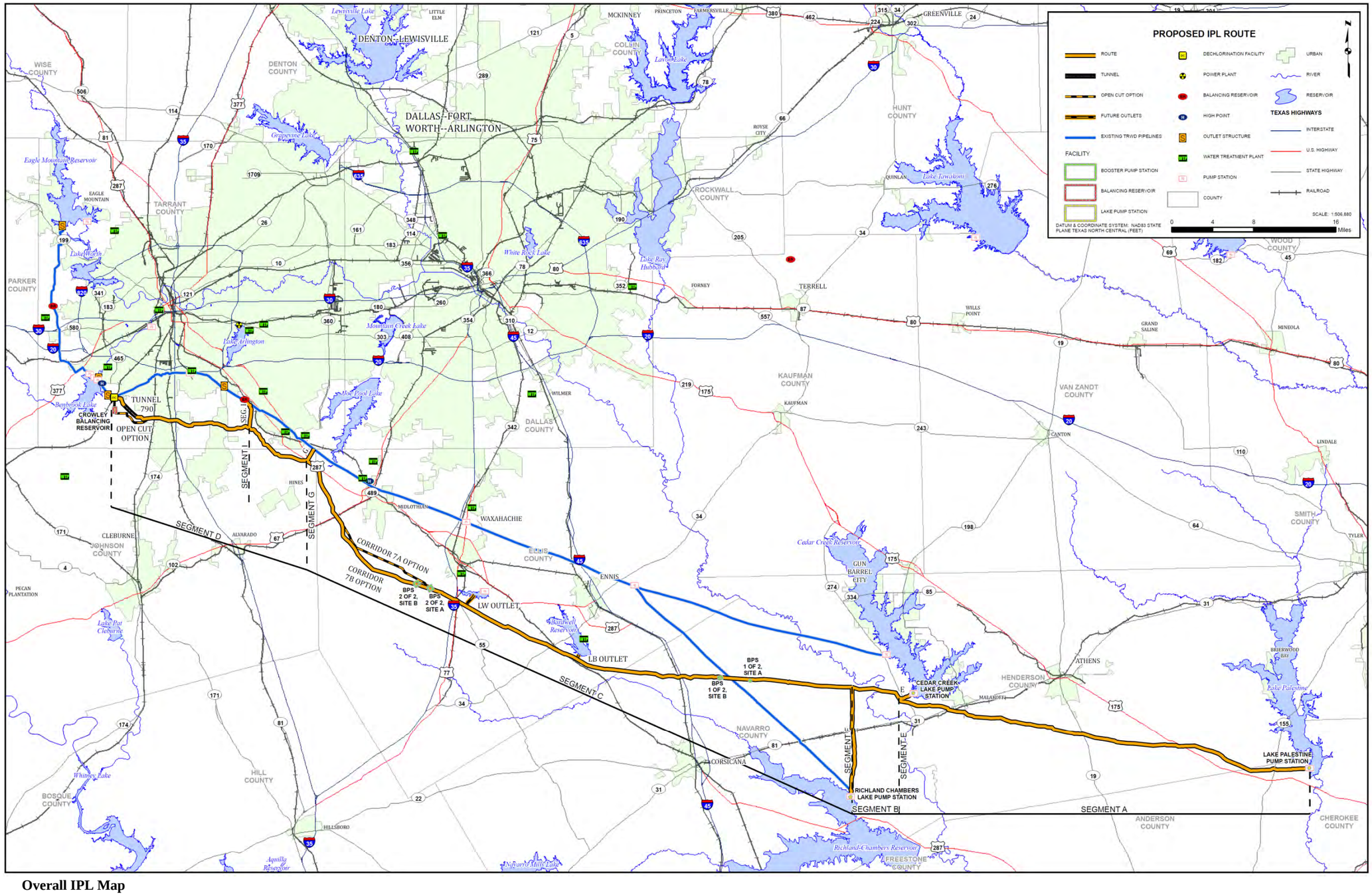

Figure 6-1. Overall IPL Map

The number of recommended facilities for the IPL project was studied in detail in this report and in previous studies. The recommended number of facilities and their locations were based on preliminary hydraulics calculations, capital costs, energy costs, and life cycle analyses. **Table 6-2** notes the number and of facilities and their pumping configuration.

Table 6-2. IPL Facilities

Facility	Flow Rate (MGD)	Operating Head Range	Number of Pumps
Lake Palestine Pump Station	150	210' – 625'	4 + 1
Cedar Creek Pump Station	127	136' – 378'	4 + 1
Richland Chambers Pump Station	70	143' – 396'	3 additional
Booster Pump Station No. 1	350	263' – 577'	6 to 8 + 1
Booster Pump Station No. 2	350	152' – 582'	6 to 8 + 1

In the previously submitted corridor selection report (*Amendment 3 and 4 Report No. 2*), there was a comparative analysis done for multiple corridors. The evaluation criteria used to differentiate the corridors has been used in this report to provide an overall and detailed view of the recommended route. **Table 6-3** is a criteria summary table for the IPL route.

Table 6-3. Evaluation Criteria Summary Table

Criteria	Unit	Quan/Qual
Number of Acquisitions (Parcels) - Total IPL	No.	877
Major Utility Xings/CCN Utility Bndry Xings	No.	26
State and US Highway Crossings	No.	19
Railroad Crossings	No.	6
Oil/Gas Line Crossings	No.	40
Pipeline Length (total IPL)	Ft	778,242
Urban Pipeline Length (Total IPL)	Ft	42,366
Major River Crossings (Total IPL)	No.	1
Stream Crossings	No.	210
Archeological and Historical Sites	No.	5
Lake and Pond Crossings	No.	42
Forested upland	ac	255
Forested Bottomland	ac	82
Native Grasslands	ac	626
Endangered Species Habitat	ac	207
USACE Property	ac	6
Pipeline Construction Costs (IPL Total)	$M	$1,047

Table 6-3(cont.). Evaluation Criteria Summary Table

Criteria	Unit	Quan/Qual
Easement Costs (IPL Total)	$M	$128
Energy Costs (IPL Total) Present Worth	$M	$895
Power Supply Costs	$M	$30
Fault Crossings	No.	5
Alluvial Soils	Ft	32,925
Terrace Soils	Ft	2,411
Native Soils	Ft	126,552
Tunnels (all are stream, highway, drainage crossings)	Ft	7,126
Deep Tunnels	Ft	8480
Rock Excavation	Ft	122,458
Levee Crossings (USACE)	No.	0
OH and UG power crossing	No.	41
Major Highway Crossings	No.	46
County Road/Local Street Crossings	No.	104
100-year Flood Plain	No.	56
Minimize Overall Pumping	Hp	100,306
Number of Redundant Power Supply Sources	No.	2

The detailed cost spreadsheets and tables noted in this report have been validated by the Program Manager's Value Engineering (VE) team. Most of the recommendations and cost estimating methodologies were adopted and incorporated into this final report after the VE workshops held through the week of May 17, 2010.

This report presents the preliminary capital and life cycle costs associated with the IPL project. Cost opinions were prepared using spreadsheet models. The expected accuracy range, degree of preparation effort, typical estimating method and level of project definition were typical of a conceptual level Class 4 estimate (using AACE International Recommended Practice No. 17R-97 - Cost Estimate Classification System) based on primarily stochastic methods. The cost parameters were based on recent bid tabs from several large diameter pipeline and pump station projects constructed in the Dallas/Fort Worth area and local manufacturers' pipeline unit cost data. Preliminary 2009 capital cost for the IPL project is approximately $1.47 B (escalated to 2015 construction mid-point this is $1.7 B). Detailed cost spreadsheets are located in Appendix F of this report. **Table 6-4** notes the capital costs for each pipeline segment and facility.

Table 6-4. IPL Capital Costs

Segment/Facility	Descriptions	Length (feet)	Design Flow	Capital Cost
Segment A	From Lake Palestine to Cedar Creek Lake	220,394	150	$222,556,000
Segment B	From Cedar Creek to Richland Chambers tie in connection	26,159	150	$43,597,000
Segment C	From Richland Chambers tie-in connection to Bachman turn-out	329,388	347	$514,880,000
Segment D	From Bachman turn-out to Benbrook	114,131	197	$181,894,000
Segment E	From Cedar Creek to IPL	8,517	127	$8,040,000
Segment F	From Richland Chambers to IPL	57,768	70	$45,388,000
Segment G	From main IPL to existing TRWD pipeline	7,120	347	$11,790,000
Segment I	From IPL to KBR	14,765	197	$19,363,000
Lake Palestine	Lake Intake Pump Station	n/a	150	$51,627,000
Cedar Creek Lake	Lake Intake Pump Station	n/a	127	$47,285,000
Richland Chambers	Lake Intake Pump Station	n/a	70	$23,980,000
BPS1	Booster pump station 1	n/a	347	$68,989,000
BPS2	Booster pump station 2	n/a	347	$68,989,000
Land Acquisition	All pipeline and facilities (acres)	n/a	n/a	$128,858,000
Power Supply	Power connection to the pumping facilities	n/a	n/a	$30,000,000

Table 6-5 contains energy cost estimates for each decade of operations based on the baseline operating conditions developed during this study. The full Operations Study that will be completed in the next phase of this IPL Project will define operating conditions more specifically and refine these operating costs. Using the values in Tables 6-4 and 6-5, the present worth of the 100-year life-cycle cost is **$3,053,000,000.**

Table 6-5. IPL Energy Costs

IPL - Energy Costs Per Decade					
2010	2020	2030	2040	2050	2060
$21,106,000	$25,661,000	$39,091,000	$57,931,000	$79,921,000	$100,099,500

Section 7
References

Geologic mapping along the entire pipeline route is currently available from the Tyler Sheet and the Dallas Sheet of the Geologic Atlas of Texas at a scale of 1:250,000. This information has been used to develop the site geologic map in Figure 1-1.

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Tarrant Regional Water District/ City of Dallas

SUMMARY REPORT

Project Viability Assessment and Business Case Evaluation of Raw Water Transmission System Integration

July, 2008

CDM/KBR

In Association with: R.W. Beck, KStrategies, TRC/Brandes, Espey Consultants, Inc., Patrick, Miller & Kropf, P.C., Crespo Consulting Services, Inc.

TARRANT REGIONAL WATER DISTRICT / CITY OF DALLAS

SUMMARY REPORT

PROJECT VIABILITY ASSESSMENT AND BUSINESS CASE EVALUATION OF RAW WATER TRANSMISSION SYSTEM INTEGRATION

July, 2008

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Executive Summary

The Tarrant Regional Water District (TRWD) and the City of Dallas Water Utilities (DWU) have developed a comprehensive list of new water management strategy recommendations that include connecting Lake Palestine to the DWU water system; completion of the TRWD constructed wetlands, and construction of TRWD's Third East Texas Pipeline from Cedar Creek and Richland-Chambers Reservoirs in approximately 2015. The geographic proximity of Lake Palestine to the existing TRWD water supplies and raw water transmission facilities at Cedar Creek and Richland-Chambers Reservoirs (as shown in **Figure ES-1**) and the similarity between the proposed implementation of these water supply strategies prompted DWU and TRWD to begin preliminary discussions about an opportunity to explore an integrated approach to bring additional water into the Dallas and Tarrant Regional Water District service areas.

The purpose of this initial Project Viability Assessment and Business Case Evaluation was to 1) identify any "fatal flaws" to developing an integrated raw water transmission system; and 2) compare the separate, independently adopted water strategies of both TRWD and DWU with integrated raw water delivery system alternatives in terms of their life-cycle cost implications, water quality and treatment implications, and permitting and environmental issues. In other words, this study compared the current water supply plans of each agency with integrated raw water transmission system alternatives.

Six tasks were completed as part of this initial Project Viability Assessment and Business Case Evaluation.

1. Integrated system operations analysis;
2. Capital and life-cycle cost analysis;
3. Facility siting constraints assessment;
4. Environmental water quality review;
5. Consideration of water treatment impacts; and
6. Permitting and regulatory review.

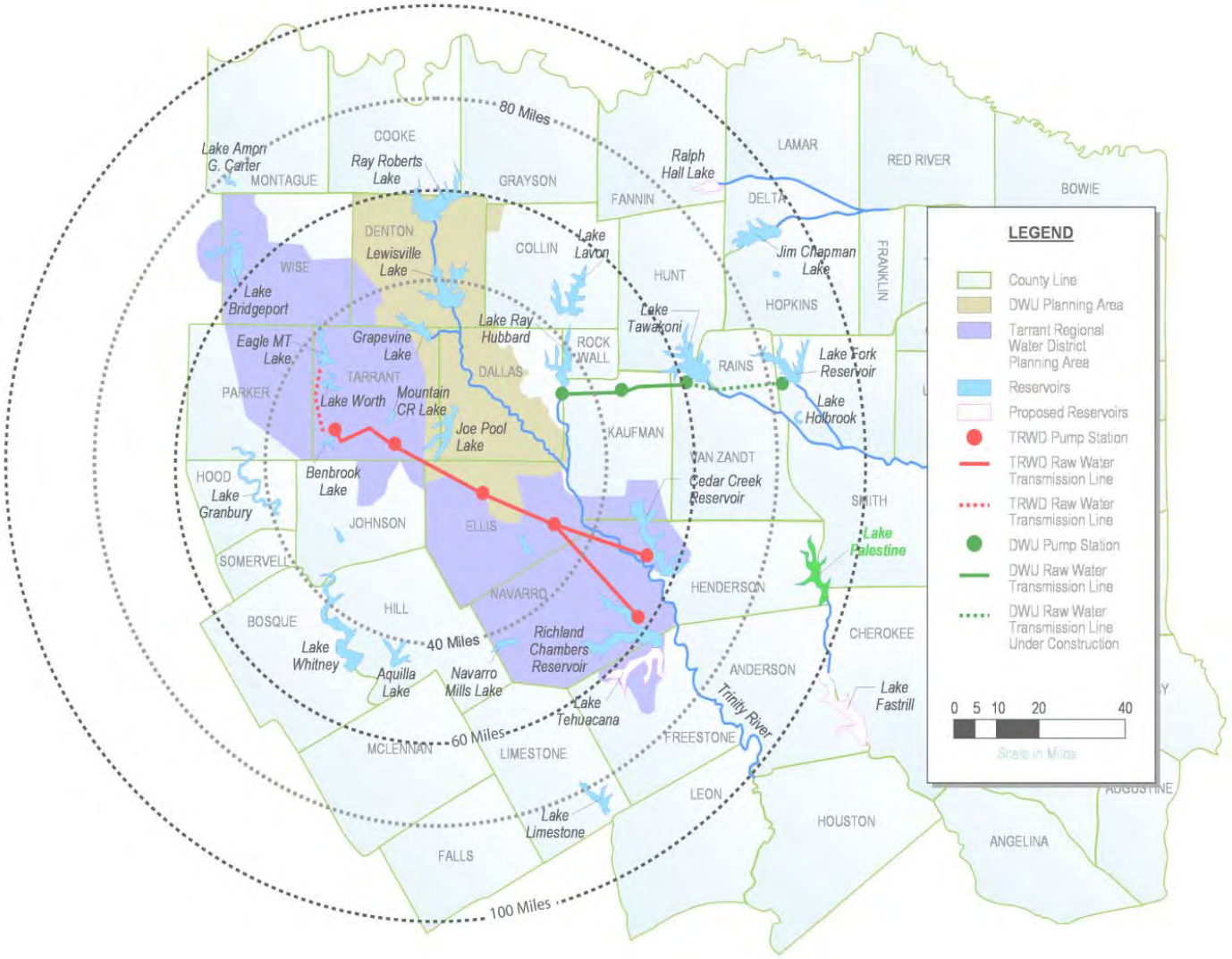


Figure ES-1
Vicinity Map

Several key objectives must be met to make a successful Business Case Evaluation that an integrated system could complement or replace existing, independent water supply plans:

- An integrated raw water transmission system alternative must enhance the redundancy, flexibility, and demand risk management of the existing water supply systems;
- An interconnected plan must make sufficient water supply available to meet demands where and when needed, under a full range of historical hydrological conditions;
- An integrated raw water transmission system alternative must reduce capital and life-cycle costs, while not contributing to unmitigated treatment or distribution costs for DWU or TRWD customers; and
- All scenarios must fully consider societal, environmental, and regulatory complexities

With these key objectives guiding the way, four project conveyance alternatives were developed through a progressive screening approach to evaluate combinations of conveyance infrastructure and interconnections, and by then selecting two Baseline Alternatives (independent water strategies) and the two most promising Interconnection Alternatives (integrated delivery systems), as described in **Table ES-1**. Additional treatment and water transmission facilities for DWU that may be required for an integrated strategy but were beyond the study boundary were also considered in this analysis (see Section 7). **Figure ES-2** maps all pipeline routes used in these project alternatives.

Table ES-1
Project Conveyance Alternatives

Alternative	Description
1 (Baseline)	**Independent Systems**: TRWD's East Texas Third Pipeline and DWU's connection of Lake Palestine to the proposed Southeast Water Treatment Plant
2 (Baseline)	**Independent Systems**: TRWD's East Texas Third Pipeline and DWU's connection of Lake Palestine to Joe Pool Lake
3 (Interconnection)	**Integrated System**: Interconnected Third Pipeline (upsized as compared to the baseline condition) with connection of Lake Palestine to Cedar Creek Reservoir and delivery to DWU at Joe Pool Lake and TRWD's customers through the Third Pipeline
4 (Interconnection)	**Integrated System**: Interconnected "Southern Pipeline" - Lake Palestine delivered to the Lake Benbrook pipeline via a pipeline route to the south of the TRWD Third Pipeline route. Delivery to DWU at Joe Pool Lake and TRWD's customers through connections to the existing system and the Lake Benbrook pipeline.

Conveyance Alternative 4 (Interconnected Southern Pipeline)

EAGLE MOUNTAIN LAKE
Eagle Mountain WTP
LAKE WORTH
Northwest WTP
Holly WTP
Pierce-Burch WTP
Electric Handley SES
LAKE ARLINGTON
Rolling Hills WTP
Arlington JFK WTP
BENBROOK LAKE
Mansfield WTP
TRA WTP
Bachman WTP
Dallas--Fort Worth--Arlington
LAKE RAY HUBBARD
Eastside WTP
SE WTP
Wax/Rocket WTP
LAKE TAWAKONI
LAKE FORK RESERVOIR
CEDAR CREEK RESERVOIR
LAKE PALESTINE
RICHLAND-CHAMBERS RESERVOIR
Interconnected Southern Pipeline (Alt 4)

Legend
- DWU PumpStations
- TRWD PumpStations
- WTP Locations
- TRWD Lakes
- Lake Palestine
- DWU Lakes
- Interconnected Southern Pipeline

1 inch equals 50,000 feet

Alternative	Description	Diameter (inches)	Length (miles)	Design Flow (with Peaking) (mgd)
4	Southern Pipeline		148	
	Palestine to CC/RC Connections	72	47	128
	CC/RC Connections to Benbrook Pipeline	108	70	331
	CC Connection to Southern Pipeline	72	8	127
	RC Connection to Southern Pipeline	66	8	76
	Southern Pipeline Connection to Joe Pool	108	16	331

CDM/KBR

Figure ES-2

Preliminary Findings

Based on the findings of this Project Viability Assessment, **Table ES-2** lists the potential advantages available to both DWU and TRWD if Lake Palestine is delivered through Interconnection Alternatives 3 or 4. The table also provides some explanation of these advantages or disadvantages.

Table ES-2
Preliminary Findings

Potential Interconnection Advantages	Benefit to DWU	Benefit to TRWD	Notes
Reduced Operating Costs	✓	✓	Operating costs within bounded system are lower in interconnected alternatives as compared to baseline alternatives. Savings more pronounced in near term and decrease over time. Near-term savings attributable to full Lake Palestine supply not being required immediately.
Water Sharing, Timing, Phasing	✓	✓	Even under drought conditions in 2020, ~80 additional mgd could be available. Portion of Lake Palestine supply required before 2020 (if DWU demand reaches 102 mgd) but could be phased through 2030. TRWD requires new water supply (above constructed wetlands) between 2030 and 2040. TRWD can sell or trade water and DWU can defer costs. Water sharing possible between both entities in short term, and in long-term during emergency situation or localized drought condition.
Demand Risk Management	✓	✓	Sharing water between the two water providers can help mitigate effects of unforeseen demand growth patterns in the TRWD or DWU systems.
Water Availability	✓	✓	Supply is limited by the permitted amounts, not water availability. During normal hydrologic periods, extra supply is available through 2060 in an interconnected system. Opportunity for both groups to benefit from this water.
Redundancy	✓	✓	Water supplier can select from multiple supply sources in times of emergency, drought, failure, etc. Opportunity for supply and failure risk management. More alternative flow pathways and connections to multiple water and power sources. Impacts of climatic variations are lessened because of diversification of reservoir locations (an interconnected system "casts a wider net").

Potential Interconnection Advantages	Benefit to DWU	Benefit to TRWD	Notes
Operational Flexibility	✓	✓	Multiple flow pathways could be used to transport water. Capitalize on advantageous opportunities for blending of sources, pump cycling schedules, system maintenance and energy management. Potential disadvantage is potential for increased operational complexity Ability to overdraft supply sources provides flexibility to system operations, the potential for lower operating costs, and risk mitigation
Regional Cooperation	✓	✓	Groundwork for interconnecting future water supply sources (Toledo Bend, Oklahoma, etc.), increasing portfolio of water supply options, reducing costs of right-of-way through earlier acquisition, providing financing risk management, facilitation of future interlocal agreements, and compliance with TWDB planning guidelines
Reduction in Life-cycle Costs	✓	✓	[1]Alternative 3 vs. 2: $537,954,000 Savings Alternative 4 vs. 2: $36,644,000 Savings
Reduction in Capital Costs	✓	✓	Alternative 3 vs. 2: $219,394,000 Savings Alternative 4 vs. 2: –$51,919,000
Environmental Water Quality	—	—	A moderate impact related to higher nutrient concentrations from Palestine will not likely affect the designated uses of the receiving reservoirs
Water Treatment Impact	—	—	Low to moderate impact on water treatment at existing and proposed WTP's. Primary impacts relate to Palestine's low alkalinity, high TOC, and high manganese concentrations
Environmental Impacts / Siting Constraints	—	—	No fatal flaws in pipeline corridors, all are potentially viable and can be recommended for further analysis. No significant differentiators between project alternatives in terms of land use, environmental, or technical (engineering) constraints
Permitting and Regulatory Issues	—	—	No fatal flaws.

[1] Interconnected Alternatives 3 and 4 deliver water to Joe Pool Lake. Baseline Alternative 2 also delivers to Joe Pool Lake but Baseline Alternative 1 delivers to the Southeast WTP. Comparisons were therefore made to Baseline Alternative 2 in this summary table because it is the most apt comparison. In subsequent report sections, comparisons with Alternative 1 are provided.

Recommendations

Based on the findings of the Business Case Evaluation in this study, **Table ES-3** summarizes a comparison of positive or negative impacts of interconnection alternatives vs. baseline plans in a Triple Bottom Line Matrix.

Table ES-3
Triple Bottom Line Matrix
Comparison of Interconnection and Baseline Alternatives

Project Element	Economic	Environmental	Social
Capital Costs	+		
Life-cycle Cost	+		+
Water Treatment Implications	–		
Permitting/Constraints	+	–	
Environmental Water Quality		–	
Water Sharing and Timing, Redundancy, Flexibility	+	+	
Regional Cooperation and Future Water Supply	+	+	+
Ellis County Service			+

This study concludes that interconnecting Lake Palestine through the TRWD system is viable – no fatal flaws have been detected in this study – and that the business case is sufficiently strong to recommend proceeding with more detailed study.

Phase II Analysis

The purpose of this study was to compare separate, independently adopted water strategies with integrated raw water delivery system alternatives, and not to select a preferred integration alternative. Though conceptual engineering and operational scenarios were studied in this effort, further analysis is needed to select a preferred integration alternative and to more fully develop how such a joint project would be planned, designed and operated to optimize economic and operational benefits to both systems. This subsequent effort must be initiated quickly due to impending supply constraints and is paramount to support development of institutional agreements and a financing strategy that will be required. It is

recommended that TRWD and the City of Dallas proceed to a Conceptual Design Phase (see Section 9 for additional detail), the purpose of which is to further develop:

- The conveyance alternatives (with more detailed hydraulic and operational analysis);
- The phasing potential of an integrated plan; and
- The cost analysis based on additional conceptual design details.

This will, in turn, support parallel organizational discussions regarding cost- and gain-sharing and the terms of a long-term institutional framework. At the conclusion of the conceptual design phase, both parties should have sufficient decision support to consider moving forward with detailed final design and construction of an interconnected raw water transmission system or independent water supply alternatives.

Data and Limitations

A short list of some of the primary project assumptions and limitations are shown below. Also, some of the key project data are summarized in **Table ES-4** to facilitate the reader's understanding of the size and scope of potential infrastructure.

- All scenarios for independent and joint water management were predicated on the assumption that DWU will utilize the full contractual yield from Lake Palestine (102 mgd) in all future years. This assumption was held constant even if some of the 102 mgd could originate from TRWD water sources in an interconnected system. This assumption was adopted for comparative purposes, and to limit the number of potential scenarios in this fatal flaw analysis by bracketing the results with limits that will not be exceeded when additional detail is added to subsequent analyses.
- This analysis used cost information and methods established in guidelines published by the Texas Water Development Board (TWDB) for use in regional water planning activities. Therefore, cost opinions were screening- or feasibility-level estimates. Unit costs were from 2006 estimates and were inflated to 1st quarter 2008 dollars. Water treatment costs are based on 2008 cost opinions.
- The water quality analysis was based on a mass balance to analyze broad impacts of blending water from Lake Palestine with the different receiving reservoirs.

Table ES-4
Information on Potential Infrastructure

Alternative	Description	Diameter (inches)	Length (miles)	Design Flow (with Peaking) (mgd)
1	Lake Pal to SE WTP	84	88	184
2	Lake Pal to Joe Pool Lake	84	105	184
1 and 2	Baseline Third Pipeline		103	
	Cedar Creek to Ennis PS	72	26	127
	Richland Cambers to Ennis PS	60	30	76
	Ennis PS to Kennedale Bal Res	84	42	203
	Kennedale Bal Res to RHWTP	96	6	203
3	Interconnected Third Pipeline		139	
	Lake Palestine to Cedar Creek	72	35	128
	Cedar Creek to Ennis PS	96	26	255
	Richland Cambers to Ennis PS	60	30	76
	Ennis PS to RH WTP	108	42	331
	Bal Res to RHWTP	126	6	331
4	Southern Pipeline		148	
	Palestine to CC/RC Connections	72	47	128
	CC/RC Connections to Benbrook Pipeline	108	70	331
	CC Connection to Southern Pipeline	72	8	127
	RC Connection to Southern Pipeline	66	8	76
	Southern Pipeline Connection to Joe Pool	108	16	331

Section 1
Introduction

1.1 Project Background

The Tarrant Regional Water District (TRWD) and the City of Dallas Water Utilities (DWU) own or hold water rights or contracts for a combined 14 surface water reservoirs and provide raw water transmission facilities for many cities and water agencies across North Central Texas. Dallas supplies treated and raw water to wholesale customers in Dallas, Collin, Denton, Ellis, and Kaufman Counties. TRWD supplies raw water and transmission services to Tarrant and 8 other counties in Region C and Johnson County in the Brazos G Region. Through 58 wholesale water agencies and cities and the DWU retail water operations, TRWD and DWU provide drinking water to 4.4 million people, a population that is expected to double in the next 50 years.

DWU has water rights for connected and unconnected surface water supplies totaling 1.8 million acre-feet per year or 1,618 million gallons per day (mgd). According to the *Long Range Water Supply Plan 2005 Update,* the actual average daily firm yield projected for 2060 is much less at 582.4 mgd (average daily). According to guidance in the Texas Water Development Board's *Exhibit B – Guidelines for Regional Water Plan Development,* "Firm yield is defined as the maximum amount of water a reservoir can provide each year during a drought of record using reasonable sedimentation rates and reasonable predetermined withdrawal patterns, assuming full utilization of upstream and downstream senior water rights and full satisfaction of environmental flow requirements and bay and estuary requirements if they apply." In general, the drought of record for North Central Texas reservoirs occurred during the drought of the 1950's.

Current population projections and water demand trends as developed in the Region C Water Plan and the 2005 Update of the Dallas Long Range Water Supply, as illustrated in **Figures 1-1a** and **1-1b**, have resulted in a comprehensive list of new water management strategy recommendations which include connecting Lake Palestine to the DWU water system, completion of the TRWD constructed wetlands, and construction of TRWD's Third East Texas Pipeline from Cedar Creek and Richland-Chambers Reservoirs in approximately 2015.

The geographic proximity of Lake Palestine to the existing TRWD water supplies and raw water transmission facilities at Cedar Creek and Richland-Chambers Reservoirs (as shown in **Figure 1-2**) and the similarity between the proposed implementation of these water supply strategies prompted DWU and TRWD to begin preliminary discussions about an opportunity to explore the conceptual feasibility of an integrated approach to bring additional water into the Dallas and Tarrant Regional Water District service areas.

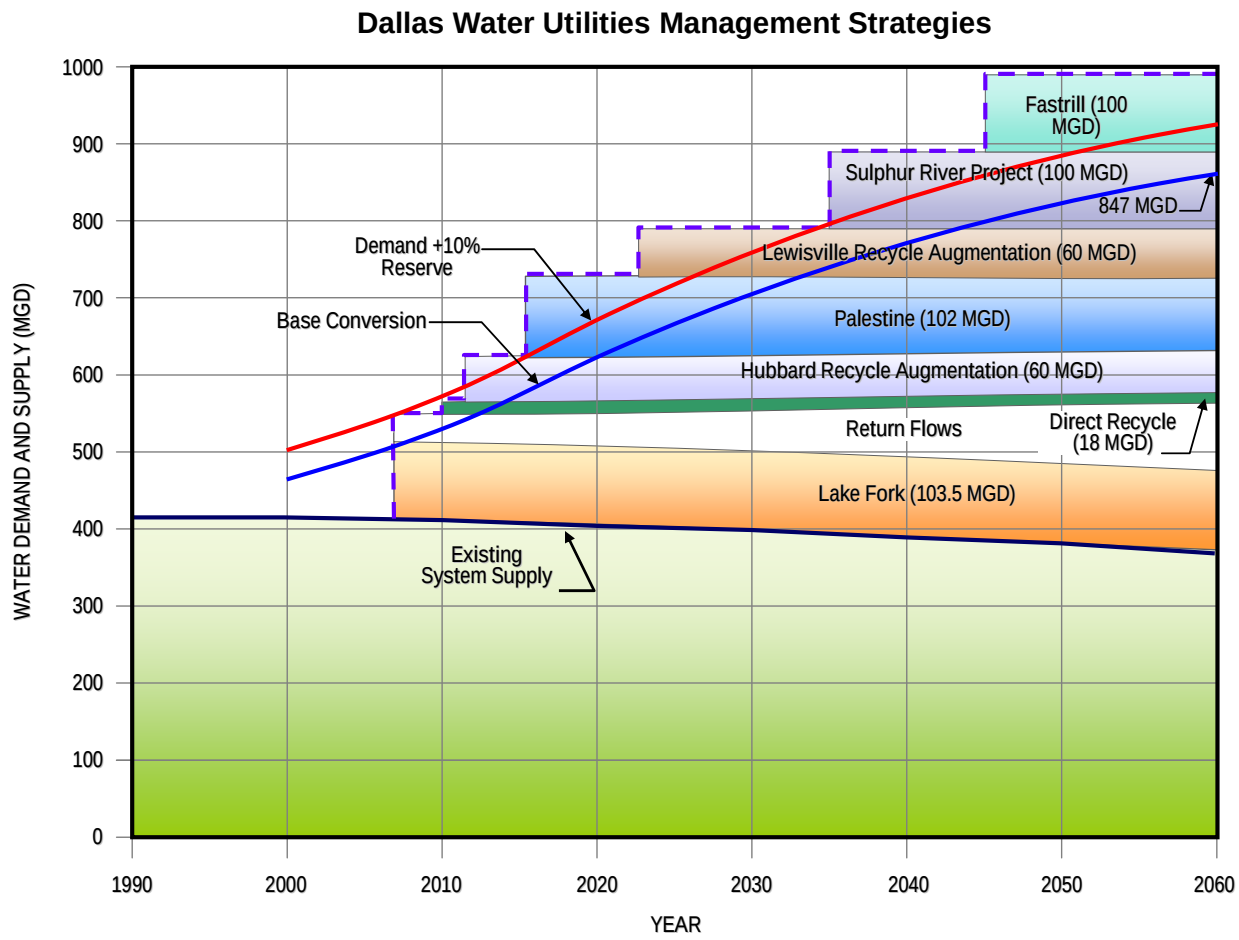


Figure 1-1a
DWU Water Management Strategies
(Figure from December 6, 2006 City Council Briefing)

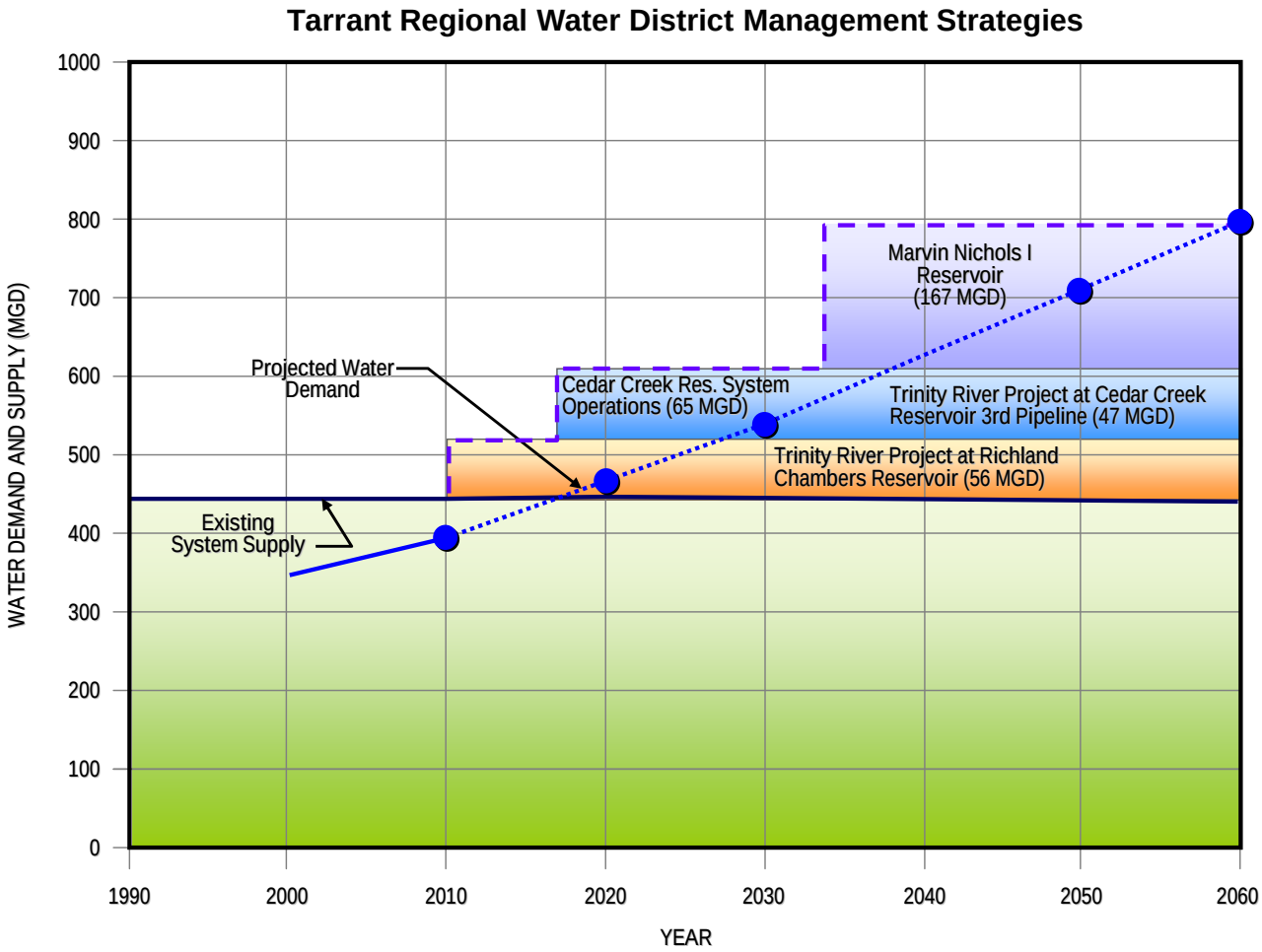


Figure 1-1b
TRWD Water Management Strategies

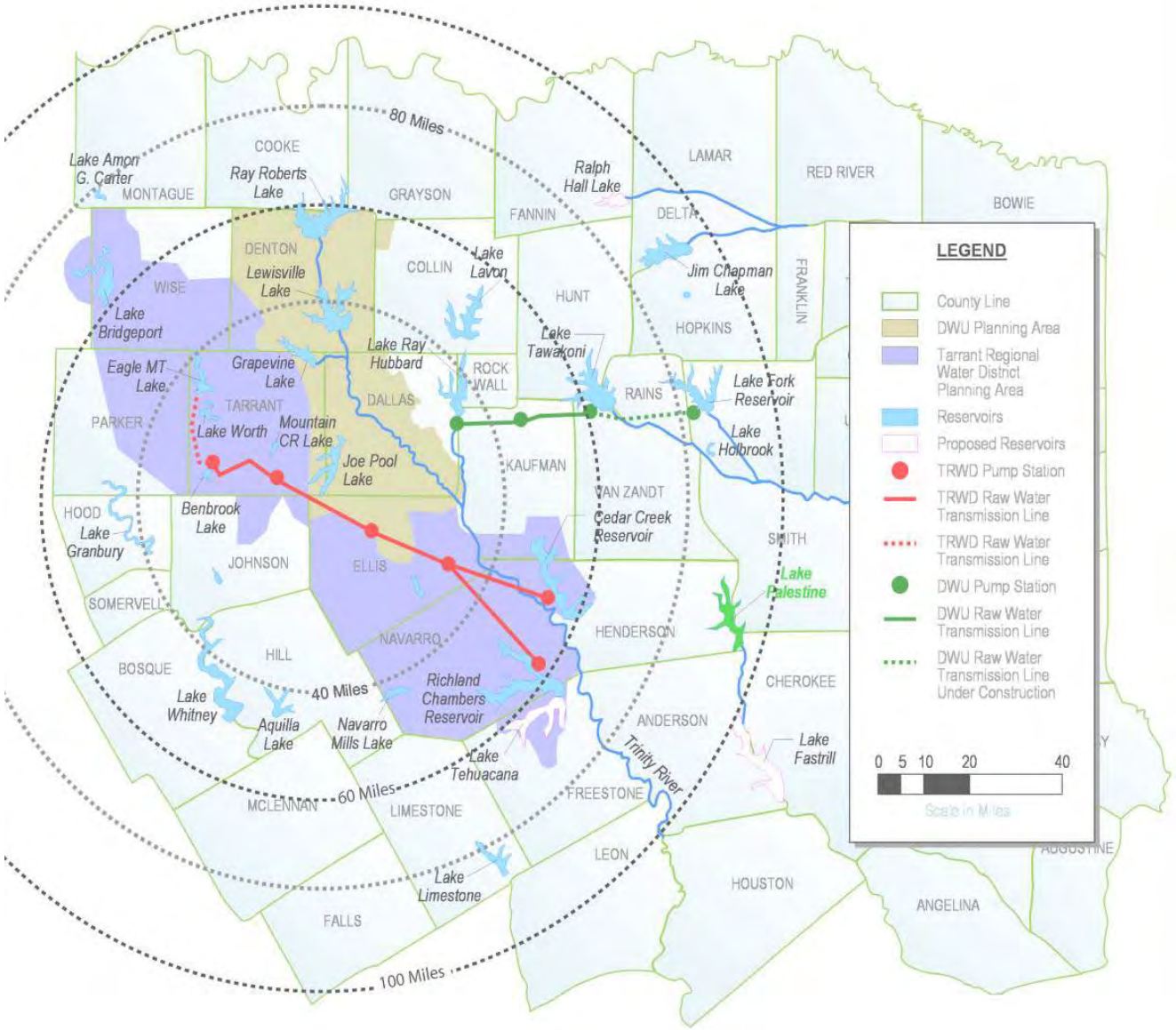


Figure 1-2
Vicinity Map

TRWD and DWU have a long history of cooperation in water supply planning, including the Texas Water Development Board regional water planning efforts initiated by the 1997 passage of Senate Bill 1 in the 75th session of the Texas Legislature. Implementation of Senate Bill 1 led to the creation of 16 regional water planning groups and the development of regional water plans that are updated every five years. The latest adopted regional water plans occurred in 2006 which led to the adoption of the 2007 State Water Plan. This study is intended to complement these ongoing regional plan updates by providing a focused initial project viability assessment and business case evaluation of integrating the TRWD and DWU raw water transmission systems, **Figure 1-2**.

1.2 Project Scope and Purpose

The purpose of this initial Project Viability Assessment and Business Case Evaluation was to 1) identify any "fatal flaws" to developing an integrated raw water transmission system; and 2) compare the separate, independently adopted water strategies of both TRWD and DWU with integrated raw water delivery system alternatives in terms of their life-cycle cost implications, water quality and treatment implications, and permitting and environmental issues. In other words, this study compared the current water supply plans of each agency with integrated raw water transmission system alternatives.

Six tasks were completed as part of this initial Project Viability Assessment and Business Case Evaluation.

1. Integrated system operations analysis;
2. Capital and life-cycle cost analysis;
3. Facility siting constraints assessment;
4. Environmental water quality review;
5. Consideration of water treatment impacts; and
6. Permitting and regulatory review.

Because of their overlapping and correlated purposes, the initial Project Viability Assessment and Business Case Evaluation are not separated in this report though the focus of each was slightly different. The purpose of the preliminary Project Viability Assessment was to identify any potential "fatal flaw" to developing an integrated system using the six tasks listed above; a fatal flaw is defined as a condition that would by itself, or when combined with other constraints, present an unavoidable obstacle that would not allow the project to proceed. The purpose of the Business Case Evaluation was to compare the separate, independently adopted water strategies of both TRWD and DWU with integrated raw water delivery system configurations using a Triple Bottom Line approach that compares the economic, environmental, and social impacts.

Several key objectives must be met to complement or replace existing, independent water supply plans:

- An integrated raw water transmission system alternative must enhance the redundancy, flexibility, and demand risk management of the existing water supply systems;
- An interconnected plan must make sufficient water supply available to meet demands where and when needed, under a full range of historical hydrological conditions;
- An integrated raw water transmission system alternative must reduce capital and life-cycle costs, while not contributing to unmitigated treatment or distribution costs for DWU or TRWD customers; and
- All scenarios must fully consider societal, environmental, and regulatory complexities

With these key objectives guiding the way, four project conveyance alternatives were developed by bounding the study (**Figure 1-3**), using a progressive screening approach to evaluate combinations of conveyance infrastructure and interconnections, and then selecting two Baseline Alternatives (independent water strategies) and the two most promising Interconnection Alternatives (integrated delivery systems), as described in **Table 1-1**. The two Baseline Alternatives represent two strategies in consideration by DWU as an independent supply option; both alternatives deliver water from Lake Palestine but differ in the delivery point (Joe Pool Lake or the Southeast Water Treatment Plant). TRWD may consider constructing a "southern pipeline" route from East Texas to Lake Benbrook as an alternative independent supply option to the Third Pipeline but this possibility was not included as a third Baseline Alternative in this analysis.

Additional treatment and water transmission facilities for DWU that may be required for an integrated strategy but were beyond the study boundary (**Figure 1-3**) are considered in Section 8 of this report. **Figure 1-4** through **Figure 1-7** illustrate the four project conveyance alternatives and **Figure 1-8** shows all pipeline routes used in these project alternatives. A description of the components in these water supply systems follows **Figure 1-8**.

Table 1-1
Project Conveyance Alternatives

Alternative	Description
1 (Baseline)	Independent Systems: TRWD's East Texas Third Pipeline and DWU's connection of Lake Palestine to the proposed Southeast Water Treatment Plant
2 (Baseline)	Independent Systems: TRWD's East Texas Third Pipeline and DWU's connection of Lake Palestine to Joe Pool Lake
3 (Interconnection)	Integrated System: Interconnected Third Pipeline (upsized as compared to the baseline condition) with connection of Lake Palestine to Cedar Creek Reservoir and delivery to DWU at Joe Pool Lake and TRWD's customers through the Third Pipeline
4 (Interconnection)	Integrated System: Interconnected "Southern Pipeline" - Lake Palestine delivered to the Lake Benbrook pipeline via a pipeline route to the south of the TRWD Third Pipeline route. Delivery to DWU at Joe Pool Lake and TRWD's customers through connections to the existing system and the Lake Benbrook pipeline.

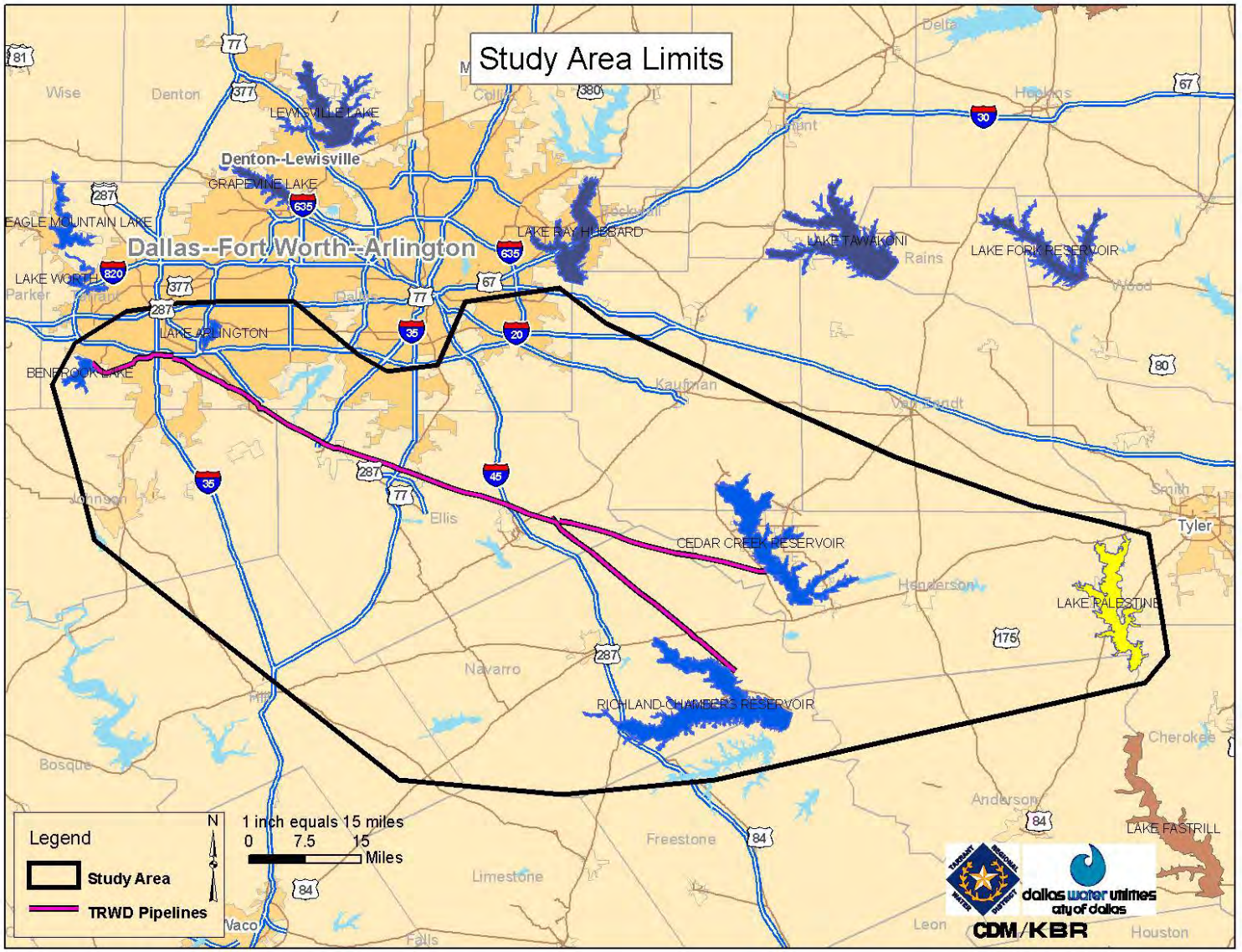
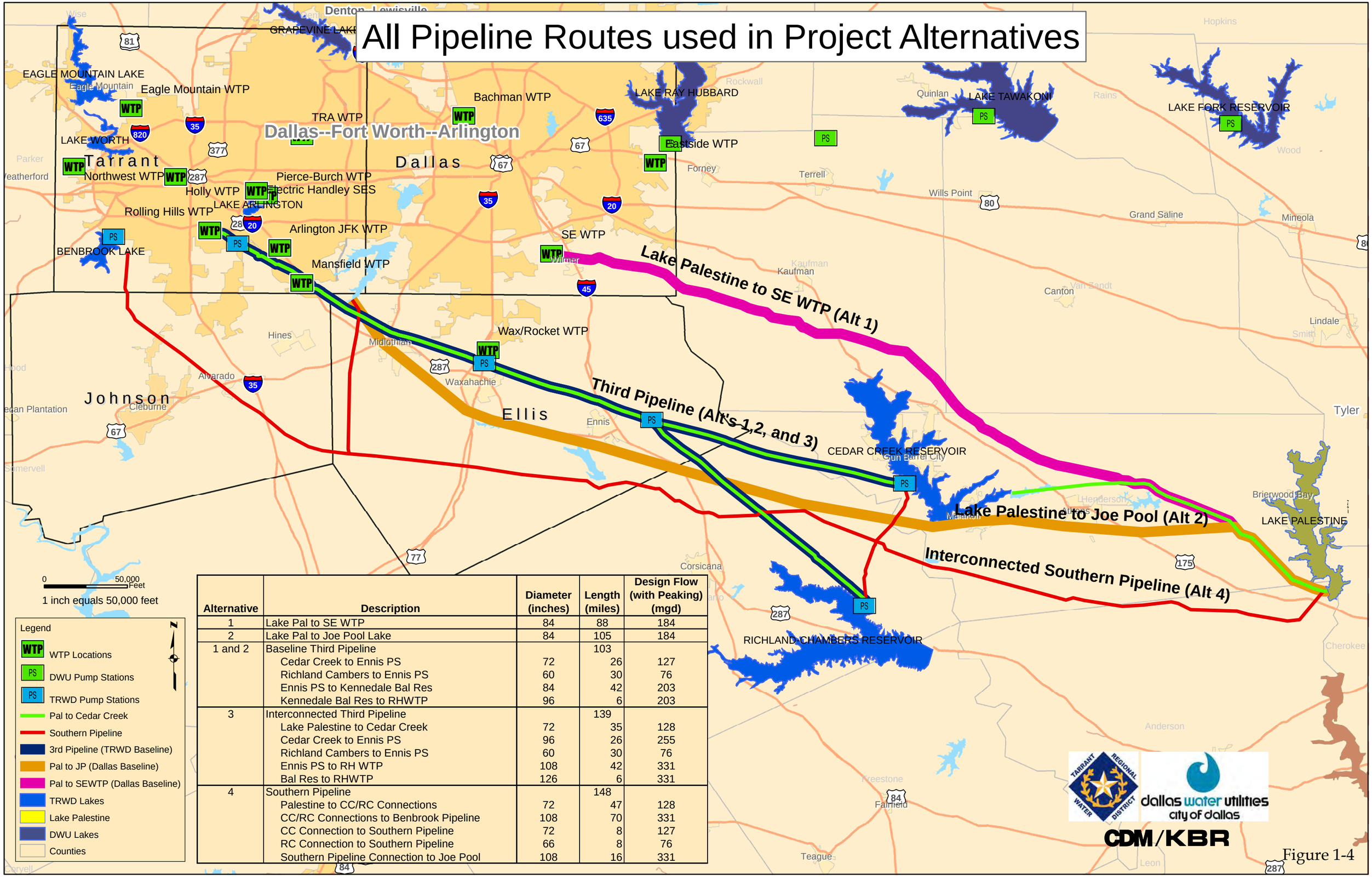


Figure 1-3
Study Area Limits

All Pipeline Routes used in Project Alternatives



0 50,000 Feet

1 inch equals 50,000 feet

Legend

- WTP Locations
- DWU Pump Stations
- TRWD Pump Stations
- Pal to Cedar Creek
- Southern Pipeline
- 3rd Pipeline (TRWD Baseline)
- Pal to JP (Dallas Baseline)
- Pal to SEWTP (Dallas Baseline)
- TRWD Lakes
- Lake Palestine
- DWU Lakes
- Counties

Alternative	Description	Diameter (inches)	Length (miles)	Design Flow (with Peaking) (mgd)
1	Lake Pal to SE WTP	84	88	184
2	Lake Pal to Joe Pool Lake	84	105	184
1 and 2	Baseline Third Pipeline		103	
	Cedar Creek to Ennis PS	72	26	127
	Richland Cambers to Ennis PS	60	30	76
	Ennis PS to Kennedale Bal Res	84	42	203
	Kennedale Bal Res to RHWTP	96	6	203
3	Interconnected Third Pipeline		139	
	Lake Palestine to Cedar Creek	72	35	128
	Cedar Creek to Ennis PS	96	26	255
	Richland Cambers to Ennis PS	60	30	76
	Ennis PS to RH WTP	108	42	331
	Bal Res to RHWTP	126	6	331
4	Southern Pipeline		148	
	Palestine to CC/RC Connections	72	47	128
	CC/RC Connections to Benbrook Pipeline	108	70	331
	CC Connection to Southern Pipeline	72	8	127
	RC Connection to Southern Pipeline	66	8	76
	Southern Pipeline Connection to Joe Pool	108	16	331

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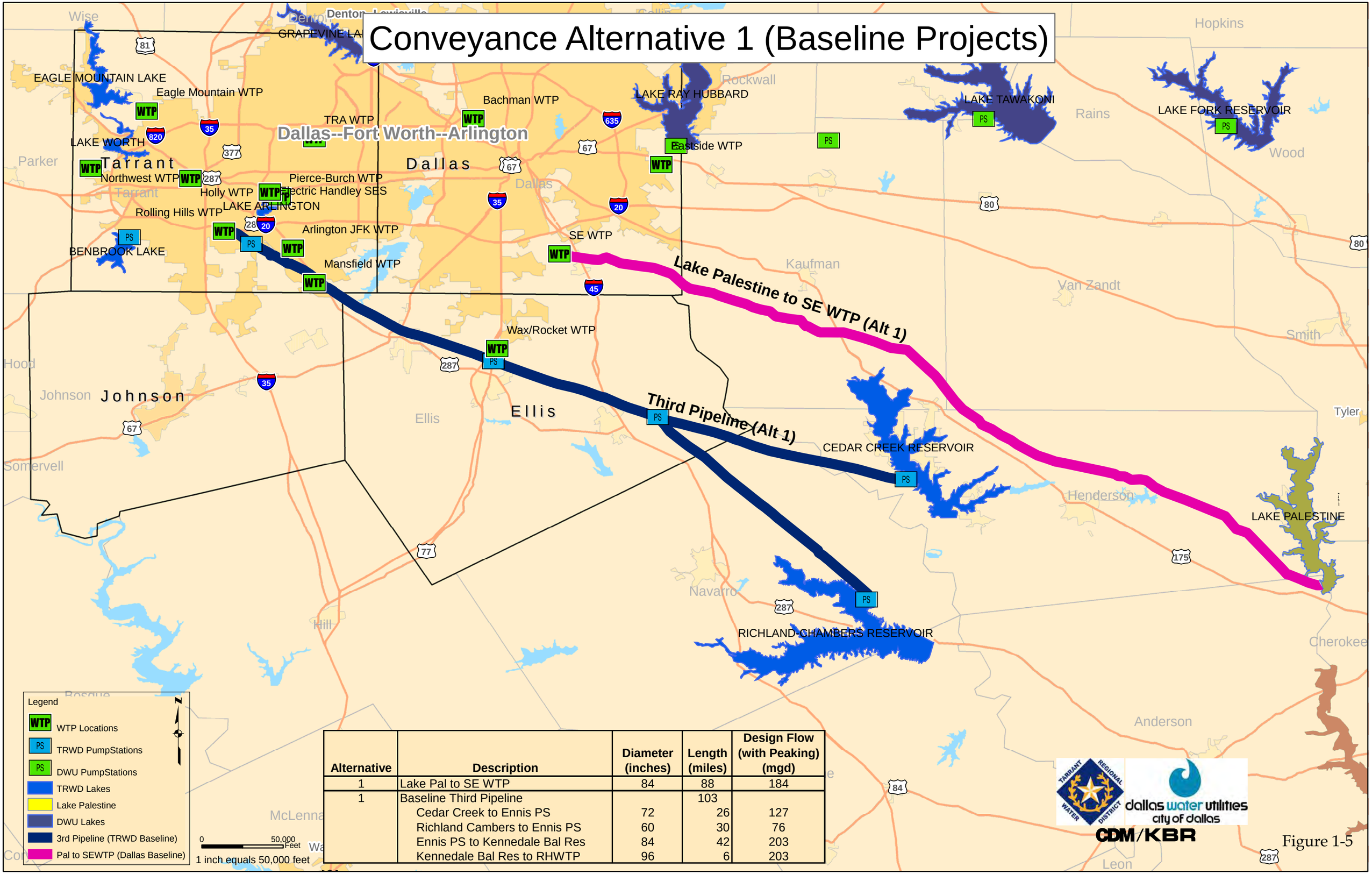
Figure 1-4

Conveyance Alternative 1 (Baseline Projects)



Legend

- WTP Locations
- TRWD PumpStations
- DWU PumpStations
- TRWD Lakes
- Lake Palestine
- DWU Lakes
- 3rd Pipeline (TRWD Baseline)
- Pal to SEWTP (Dallas Baseline)

0 50,000 Feet

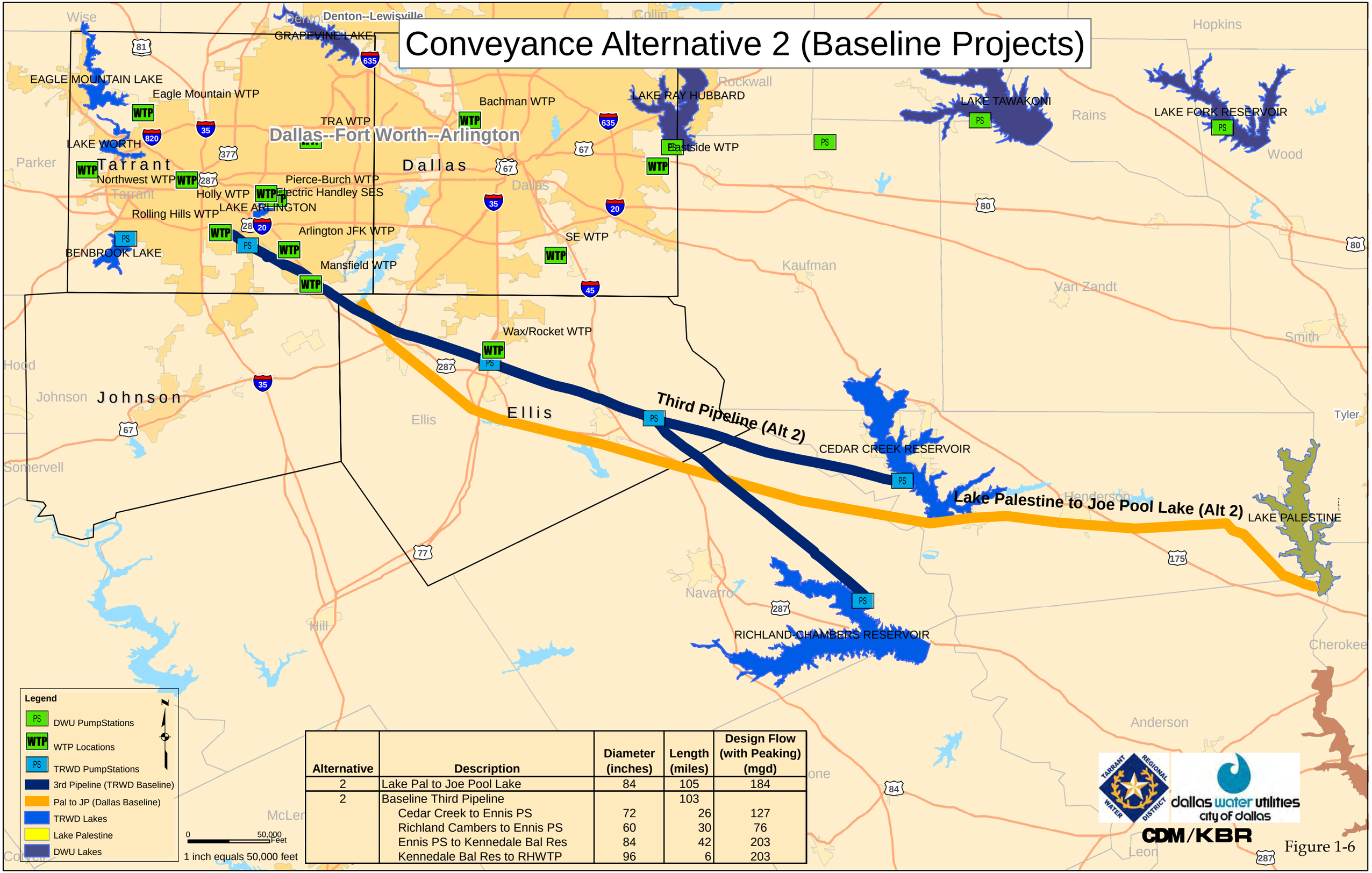
1 inch equals 50,000 feet

Alternative	Description	Diameter (inches)	Length (miles)	Design Flow (with Peaking) (mgd)
1	Lake Pal to SE WTP	84	88	184
1	Baseline Third Pipeline		103	
	Cedar Creek to Ennis PS	72	26	127
	Richland Cambers to Ennis PS	60	30	76
	Ennis PS to Kennedale Bal Res	84	42	203
	Kennedale Bal Res to RHWTP	96	6	203

CDM/KBR

Figure 1-5

Conveyance Alternative 2 (Baseline Projects)



Legend

- PS — DWU PumpStations
- WTP — WTP Locations
- PS — TRWD PumpStations
- 3rd Pipeline (TRWD Baseline)
- Pal to JP (Dallas Baseline)
- TRWD Lakes
- Lake Palestine
- DWU Lakes

0 50,000 Feet

1 inch equals 50,000 feet

Alternative	Description	Diameter (inches)	Length (miles)	Design Flow (with Peaking) (mgd)
2	Lake Pal to Joe Pool Lake	84	105	184
2	Baseline Third Pipeline		103	
	Cedar Creek to Ennis PS	72	26	127
	Richland Cambers to Ennis PS	60	30	76
	Ennis PS to Kennedale Bal Res	84	42	203
	Kennedale Bal Res to RHWTP	96	6	203

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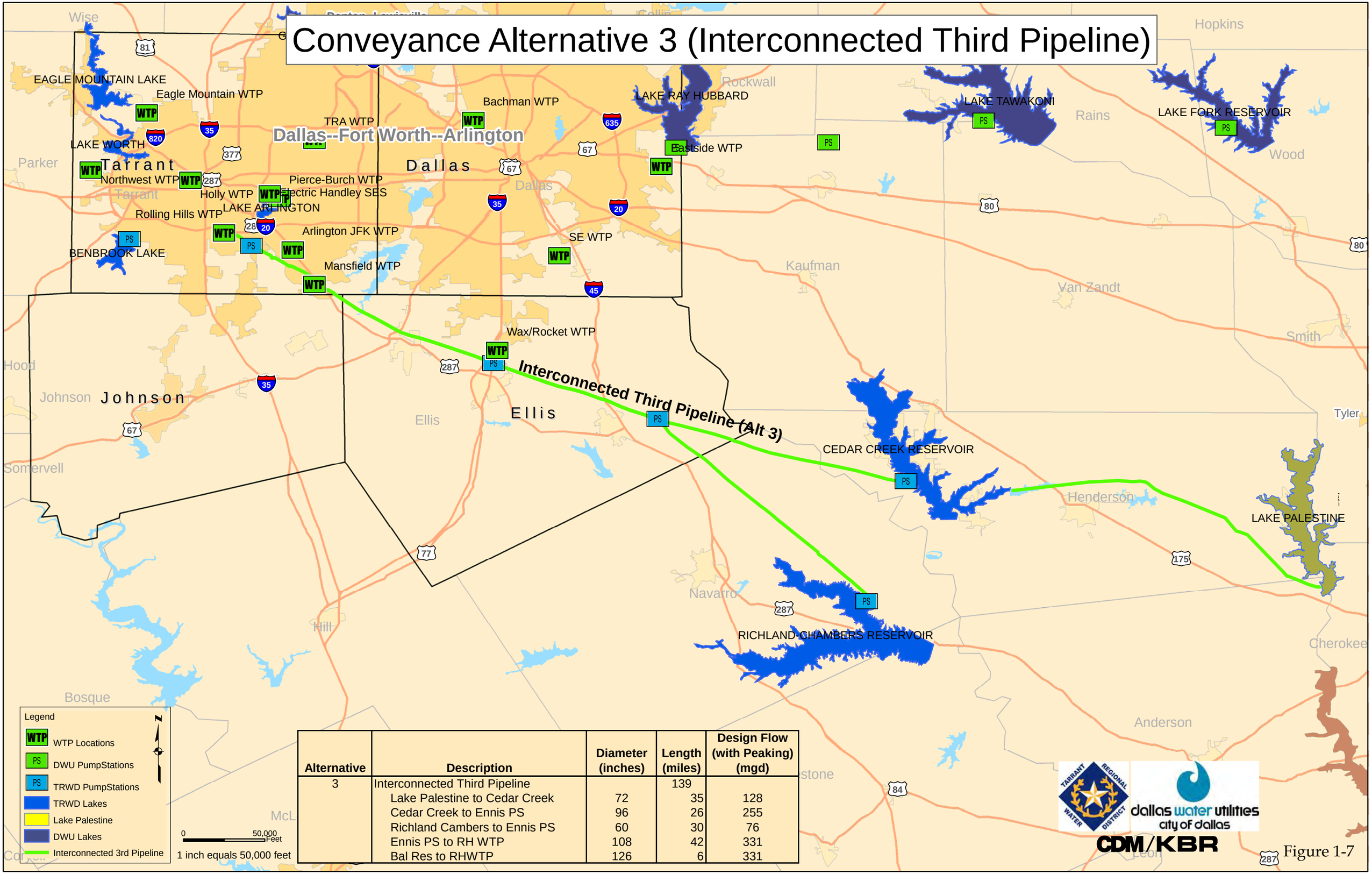
Figure 1-6

Conveyance Alternative 3 (Interconnected Third Pipeline)



Legend

- WTP — WTP Locations
- PS — DWU PumpStations
- PS — TRWD PumpStations
- TRWD Lakes
- Lake Palestine
- DWU Lakes
- Interconnected 3rd Pipeline

N

0 50,000 Feet

1 inch equals 50,000 feet

Alternative	Description	Diameter (inches)	Length (miles)	Design Flow (with Peaking) (mgd)
3	Interconnected Third Pipeline		139	
	Lake Palestine to Cedar Creek	72	35	128
	Cedar Creek to Ennis PS	96	26	255
	Richland Cambers to Ennis PS	60	30	76
	Ennis PS to RH WTP	108	42	331
	Bal Res to RHWTP	126	6	331

Tarrant Regional Water District

dallas water utilities
city of dallas

CDM/KBR

Figure 1-7

Conveyance Alternative 4 (Interconnected Southern Pipeline)

Interconnected Southern Pipeline (Alt 4)

Alternative	Description	Diameter (inches)	Length (miles)	Design Flow (with Peaking) (mgd)
4	Southern Pipeline		148	
	Palestine to CC/RC Connections	72	47	128
	CC/RC Connections to Benbrook Pipeline	108	70	331
	CC Connection to Southern Pipeline	72	8	127
	RC Connection to Southern Pipeline	66	8	76
	Southern Pipeline Connection to Joe Pool	108	16	331

Legend
- PS — DWU PumpStations
- PS — TRWD PumpStations
- WTP — WTP Locations
- TRWD Lakes
- Lake Palestine
- DWU Lakes
- Interconnected Southern Pipeline

0 50,000 Feet
1 inch equals 50,000 feet

CDM/KBR

Figure 1-8

1.3 System Descriptions

1.3.1 Lake Palestine

Lake Palestine is owned and operated by the Upper Neches River Municipal Water Authority (UNRMWA) and is located in Region I (East Texas Region) approximately 85 miles southeast of Dallas. UNMWA has contracted to supply up to 114,937 acre-feet per year, (average 102 million gallons per day) to Dallas which holds an interbasin transfer permit to the Trinity River Basin. The 2006 Region C Water Plan recommends as a Water Management Strategy (WMS) that Dallas construct the infrastructure to transport this water from Lake Palestine to Dallas because of its relatively low cost and environmental and permitting risk impact.

1.3.2 Proposed Southeast Water Treatment Plant and Joe Pool Lake

The proposed DWU Raw Water Supply System for the Southeast Water Treatment Plant (SEWTP) would convey Lake Palestine and, possibly in the future, Lake Fastrill, Toledo Bend Reservoir, and other East Texas water supplies to the site purchased for the Southeast Water Treatment Plant. Updated planning level cost estimates have been developed for the raw water transmission facilities needed to transport water to this site for Dallas.

Lake Palestine Spillway

Joe Pool Lake is located on Mountain Creek in the Trinity River Basin in both Dallas and Tarrant Counties. This U.S. Army Corps of Engineers (USACE) reservoir has conservation storage of 176,900 acre-feet. The Trinity River Authority (TRA) has a water supply agreement with the Corps of Engineers and holds the water rights for 17,000 acre-feet per year, or 15 mgd average. According to the Texas Commission on Environmental Quality (TCEQ) Trinity River Water Availability Model (WAM), the available water supply from Joe Pool Lake in 2060 will be 10,000 acre-feet per year. For purposes of this investigation, conveyance alternative 2 and both interconnection alternatives deliver water to the Joe Pool Lake vicinity. Currently Joe Pool Lake serves as a public water supply for the City of Midlothian, which has a water intake structure in the southeast leg of the lake. TRA also has a water intake structure in Cedar Hill State Park, but it is not currently in use. Several other entities have a contractual interest in Joe Pool Lake with TRA but are not currently using it as a drinking water supply.

- City of Grand Prairie – 1,795 acre-feet per year for municipal and domestic uses.
- City of Duncanville – 1,197 acre-feet per year for municipal and domestic uses.

- Midlothian Water District – 6,662 acre-feet per year for municipal and domestic uses

- City of Cedar Hill – 7,346 acre-feet per year for municipal and domestic and industrial uses.

1.3.3 TRWD East Texas Supply

Cedar Creek Reservoir is located on Cedar Creek in the Trinity River Basin in Henderson and Kaufman Counties. The reservoir has 678,900 acre-feet of conservation storage. TRWD holds a water right for diversion of 175,000 acre-feet per year (156 mgd average). According to the TCEQ Trinity River WAM, the available safe yield (synonymous to firm yield except reservoir is left with one year of storage at the end of the critical drought as opposed to zero storage) from Cedar Creek in 2060 will be 175,000 acre-feet per year. TRWD conveys water from Cedar Creek Reservoir through an existing pipeline and will increase conveyance capacity with the proposed Third Pipeline to convey the full 175,000 acre-feet per year and an additional 52,500 acre-feet per year from the Trinity River constructed wetlands.

Richland-Chambers Reservoir is located on Richland and Chambers Creeks in the Trinity River Basin in Freestone and Navarro Counties. The reservoir has 1,135,000 acre-feet of conservation storage. TRWD and the City of Corsicana hold combined water rights in the reservoir totaling 223,650 acre-feet per year with TRWD holding 210,000 acre-feet per year (187 mgd average). According to the TCEQ Trinity River WAM results, the available safe yield from Richland-Chambers will decrease by approximately 35,300 acre-feet per year from 2010 to 2060. However, TRWD analysis has shown that sedimentation rates currently projected in the Texas regional planning models are overstated and that actual rates will have a negligible effect on the safe yield. TRWD conveys supply from Richland-Chambers Reservoir through an existing pipeline and will increase conveyance capacity with the proposed Third Pipeline to convey the full 210,000 acre-feet per year and an additional 63,000 acre-feet per year from the Trinity River constructed wetlands.

The system also includes Lake Arlington, owned by the City of Arlington and ExTx LaPorte, and Lake Benbrook owned by the Corps of Engineers with TRWD holding a contract with USACE and a TCEQ water right permit. Both of these reservoirs provide terminal storage for the District's customers with relatively small yields from upstream runoff. Lake Benbrook is located on the Clear Fork of the Trinity River in Tarrant County and has conservation storage of 72,500 acre-feet; TRWD has a maximum overdraft diversion of 72,500 acre-feet per year on a non-priority basis. Lake Arlington, also in Tarrant County, is located on Village Creek and has 45,710 acre-feet of conservation storage. These terminal storage reservoirs primarily receive waters pumped from Richland-Chambers or Cedar Creek Reservoirs.

The Tarrant Regional Water District also has received a water rights permit from the Texas Commission on Environmental Quality allowing the diversion of return flows of treated wastewater from the Trinity River. TRWD has plans to pump the return

flows from the Trinity River into constructed wetlands and then into Richland-Chambers Reservoir and Cedar Creek Reservoir. This project will provide an additional 115,500 acre-feet per year of new supply. The Region C Plan recommends this relatively inexpensive source of water and the associated raw water delivery facilities of a third pipeline as a preferred water management strategy. For purposes of this study, both the constructed wetlands at the two reservoirs and all the additional conveyance facilities to deliver the constructed wetlands water supply to Richland-Chambers and Cedar Creek Reservoirs are assumed to be complete and in use by 2020.

1.3.4 TRWD West Fork Supply

The West Fork Trinity River portion of TRWD's system includes Lake Bridgeport and Eagle Mountain Lake owned and operated by the District, and Lake Worth owned by the City of Fort Worth. Water from the West Fork of the Trinity River Basin flows by gravity from Lake Bridgeport into Eagle Mountain Lake and then on to Lake Worth. In May 2008 the District completed its Eagle Mountain Connection Project which includes pipelines, pump stations and other facilities to interconnect the District's eastern and western supplies. Through this project, water from Cedar Creek and Richland-Chambers Reservoirs is conveyed to Eagle Mountain Lake.

The volume and rate of water delivered to Eagle Mountain Lake through the Eagle Mountain Connection was included in the modeling. No detailed modeling of the West Fork supply was included in this analysis because integration of the raw water system will not affect the West Fork – it acts as an external demand or supply to the integrated system but it is not requisite to model the disaggregated West Fork supplies in this study.

1.4 Assumptions and Limitations

As described in Section 1.2, the purpose of this initial Project Viability Assessment was to identify any potential "fatal flaw" to developing an integrated system and the purpose of the Business Case Evaluation was to compare the separate, independently adopted water strategies of both TRWD and DWU with integrated raw water delivery system configurations. This is therefore a preliminary, fatal-flaw level analysis with inherent limitations and risk factors. This section captures the principle assumptions and limitations in the six project analyses.

1.4.1 Integrated Operations Analysis

To examine some of the principal differences between routing water from Lake Palestine directly to DWU's terminal points and routing it through new and existing TRWD infrastructure, an integrated system operations model was developed. The model is neither a comprehensive hydraulic model nor a prescriptive day-to-day operations model. *The results from the optimization program should not be construed as a prescriptive approach for future operations, but rather, as a simple means of bounding the theoretical performance of the conveyance alternatives.*

- Operations costs consider only the energy cost in the conveyance system. Routine operations and maintenance is not included and treatment costs are also excluded.

- No adjustments were made to apply downstream release requirements that were not explicitly included in the RiverWare model.

- This optimization model is not intended to function as a hydraulic model. It is intended to provide an understanding of basic delivery requirements necessary to identify energy needs and costs associated with moving water through the system. Calculations for head requirements (elevation and line losses) were conducted outside of the model and these relationships were imported in simplified form so that movement of water incurs costs on a relative basis throughout the system.

- All scenarios for independent and joint water management were predicated on the assumption that DWU requires the full yield from Lake Palestine (102 mgd) in all future years. This assumption was held constant even if some of the 102 mgd could originate from TRWD water sources in an interconnected system. This assumption was adopted for comparative purposes, and to limit the number of potential scenarios in this fatal flaw analysis by bracketing the results. Though other scenarios with varying DWU demand on Lake Palestine water will provide enhanced detail, the fundamental question of the potential opportunities for benefits through integration is captured with this assumption and additional detail will not create results outside of the limits imposed by this assumption.

1.4.2 Capital and Life-Cycle Cost Analysis

The purpose of the cost analysis task was to develop a screening level/conceptual opinion of probable capital and lifecycle cost for each project conveyance alternative and to conduct a present worth economic comparison between the Baseline and Interconnection alternatives. The cost analyses represent total costs for water delivery and do not allocate costs between DWU and TRWD. The capital cost opinions presented herein are based on guidelines established by the Texas Water Development Board (TWDB) for use in regional water planning activities.

These cost opinions are roughly equivalent to a screening- or feasibility-level Class 4 to Class 5 estimate (per AACEI International Recommended Practice No. 17R-97, as shown in **Figure 1-9**).

Spreadsheet cost models were developed to aid in the formulation of a conceptual opinion of probable capital cost for each project scenario. These cost models incorporate planning level engineering design assumptions and a contingency appropriate to this early phase of project definition and development and in consideration of the limited availability of site-specific data.

Capital cost estimates derived from TWDB guidelines for regional water planning include assumptions and inherent uncertainties that may introduce significant

inaccuracies into the analysis. These assumptions and uncertainties will be revisited and refined through subsequent phases of project definition and development. Key assumptions and uncertainties include:

1. The analysis does not include detailed cost engineering to determine probable material and labor costs at the time of construction, possibly five or more years into the future. Unit costs are based on updates from 2002 levels to 2006 levels, prepared by Region C for incorporation into the 2011 water plan. These 2002 cost levels are currently shown in tables in Appendix U of the 2006 Region C Water Plan. For this analysis, Engineering News Record (ENR) cost indexes and U.S. Bureau of Labor Statistics data (Producer Price Index, Material Price Index) were used to escalate the unit costs of pipelines and pump stations, the two largest cost components of each project scenario, from 2006 to 2008.

2. Costs associated with the closure, mitigation and/or relocation of oil and gas wells, environmental mitigation, relocations of existing infrastructure, and other similar design issues cannot be accurately estimated at this stage of project definition and development.

	Primary Characteristic	*Secondary Characteristic*			
ESTIMATE CLASS	LEVEL OF PROJECT DEFINITION Expressed as % of complete definition	END USAGE Typical purpose of estimate	METHODOLOGY Typical estimating method	EXPECTED ACCURACY RANGE Typical +/- range relative to best index of 1 [a]	PREPARATION EFFORT Typical degree of effort relative to least cost of index 1 [b]
Class 5	0% to 2%	Screening or Feasibility	Stochastic or Judgment	4 to 20	1
Class 4	1% to 15%	Concept Study or Feasibility	Primary Stochastic	3 to 12	2 to 4
Class 3	10% to 40%	Budget, Authorization or Control	Mixed, but Primarily Stochastic	2 to 6	3 to 10
Class 2	30% to 70%	Control or Bid/Tender	Primarily Deterministic	1 to 3	5 to 20
Class 1	50% to 100%	Check Estimate or Bid/Tender	Deterministic	1	10 to 100

Notes: [a] If the range index of value "1" represents +10/5%, then an index value of 10 represents +100/-50%
[b] if the cost index value of "1" represents 0.005% of project costs, then an index value of 100 represents 0.5%.

Figure 1-9
Association for the Advancement of Cost Engineering,
Recommended Practice 17R-97; Cost Estimating Classification System

3. Real estate acquisition costs and issues cannot be evaluated at this stage of project development and will undoubtedly impact project cost estimates. In addition to uncertainties regarding the cost of real estate acquisition, capital cost estimates for each project alternative could be impacted if real estate issues dictate transmission system alignments that are longer or are at higher elevations, or both. A more detailed analysis of alternative pipeline alignments will be performed in a subsequent phase of project development. Rates of $3,000 per acre of permanent easement and $1,500 per acre of temporary easement were used (per Region C guidelines).

4. Per direction received in Workshop 1, additional conveyance capacity to accommodate future supply sources to the east was not included in the conceptual design of these systems. Instead, it was assumed that the cost of easements will include right-of-way for pipelines in the project scenarios of this study and additional right-of-way sufficient for one additional pipeline of equal dimensions.

5. In alternatives utilizing the Third Pipeline route, it may be possible to upgrade or expand existing pump stations to accommodate additional capacity. In this analysis, these cost savings were not accounted for in an effort to be conservative.

1.4.3 Future Capital and Life-Cycle Cost Analysis

The purpose of the capital and life cycle cost analysis was to provide preliminary data to allow the sponsors, DWU and TRWD, to make an informed decision as to whether to proceed with further definition and development of a project to integrate water transmission facilities to deliver raw water from Lake Palestine and the TRWD East Texas system. Because of the high-level nature of the analysis, the capital cost estimates and lifecycle cost analyses will need to be refined and updated in subsequent phases of project definition and development. Also, additional analysis will provide more information to differentiate between interconnection alternatives and between baseline and interconnection alternatives. Recommended refinements in the cost analysis are:

- Though phasing opportunities are discussed in section 2 of this report, phasing is not addressed in the cost analyses. However, it could have significant impacts on lifecycle costs, potentially increasing the cost differential between the Baseline and Interconnection scenarios. Specifically, phasing could result in significant reduction of costs associated with the Interconnected Southern Pipeline due to the potential to defer development of transmission facilities required to deliver water to Lake Benbrook. Though phasing could be a proportionally larger benefit in terms of the life cycle costs of the Southern Pipeline, the purpose of this investigation was not to identify a preferred alternative but rather to compare Baseline and Interconnected project scenarios.

- The location of booster and intake pump stations will impact the cost of electricity inasmuch as those facilities could be served by suppliers with lower or higher rates. However, because these locations will likely change on the order of many miles, the energy provider used in this analysis (based on conceptual siting) may change in subsequent phases and updates to cost analyses should include more specific energy cost data as it becomes available.

- Refinements and updates to the capital cost modeling should occur as specific alignments are selected and as the design of facilities progresses.

- These cost analyses represent total costs for water delivery and do not attempt to allocate costs to DWU and TRWD systems. Subsequent phases in this feasibility assessment will address cost and gain sharing.

1.4.4 Constraints Analysis

A preliminary facility siting constraints analysis was performed to identify potential fatal flaws to locating water transmission facilities along select pipeline corridors and to make a comparison between project conveyance alternatives. The preliminary constraints analysis was accomplished using publicly available data from secondary sources with no field data collection. Because additional site-specific data and more detailed analysis will be required in subsequent phases to fully assess potential constraints and impacts, the "opinion of probable impact" will likely be modified as additional data is acquired and pipeline alignments are refined.

The primary components of each of the project conveyance alternatives are transmission pipelines. Though intakes and booster pump stations are also required, the location of these facilities is at a conceptual, approximate level. Because these locations will likely change on the order of many miles throughout the planning and design phases, analyzing constraints to siting pumping facilities was not appropriate at this stage and is reserved for future phases when these locations are less subject to change.

The preliminary findings of the constraints analysis are contained in the Alternatives Evaluation Matrix (AEM), with an analysis of each evaluation criterion and component, and an impact rating for each evaluation criterion. The evaluation is qualitative and will be modified and enhanced as additional data become available and as engineering analyses progress in subsequent phases of project definition and development. It should be noted that the ratings developed in this analysis do not consider several factors, although these factors will be evaluated during subsequent phases:

- Construction schedule;

- Permitting requirements;

- Political favorability;

- Land ownership (data not yet available);
- Operations and Maintenance considerations (beyond cost, which is included in the lifecycle cost analysis); and
- System compatibility and operations.

1.4.5 Environmental Water Quality and Water Treatment Considerations

The purpose of the environmental water quality review was to determine impacts on receiving water quality by the introduction of Lake Palestine water under varying conditions into Lake Benbrook, Cedar Creek Reservoir, Richland-Chambers Reservoir, and Joe Pool Lake. The water quality review included data collection and analysis, mass balance calculations, and a water quality evaluation.

Atrazine data was not available in Lake Palestine or Cedar Creek Reservoir and bromide data was not available in Joe Pool Lake. The majority of the bromide data for Lake Benbrook, Cedar Creek Reservoir, and Richland-Chambers Reservoir included reported values with numerous detection limits. The detection limits were not consistent from reservoir to reservoir and were much higher than the suspected actual concentration. Accordingly, the bromide data were not utilized as part of this environmental water quality evaluation due to the inconsistency of the testing protocols and concerns about the integrity of the available reported data.

The results of this water quality analysis were based on a mass balance of water from Lake Palestine and the receiving reservoir. While this evaluation can provide information that is useful in a planning context by analyzing the broad impacts of blending water from Lake Palestine with the different reservoirs, a more comprehensive analysis should be conducted to provide the level of detail needed for final decision making purposes. The development of hydrodynamic and water quality models would provide the level of detail needed to predict the specific impact on the receiving reservoir.

As noted in the 2006 Region C Water Plan, in general, East Texas reservoirs such as Lake Palestine have higher concentrations of nutrients than the evaluated receiving reservoirs. The ultimate impact of the imported Lake Palestine water with its higher nutrient concentrations is difficult to predict in this evaluation due to the complex kinetic relationships between nutrients and chlorophyll-a. It should be noted, however, that in the Region C Water Plan all of the water management strategies involving importation of water from East Texas were considered to have “low” or medium-low” impacts on the key water quality parameters.

Section 2
Integrated Operations

2.1 Purpose

The purpose of this analysis was to identify opportunities for benefits, or potential disadvantages, to both TRWD and DWU through integrated operations of the raw water transmission systems from Lake Palestine, Richland-Chambers Reservoir, and Cedar Creek Reservoir. This comparison of Baseline Alternatives 1 and 2 with Interconnection Alternatives 3 and 4 (see **Table 1-1**) was driven by a system operations model and the team's water resource planning experience. This model was formulated as a decision-support system that permitted the user to create an array of scenarios that help answer a series of primary and secondary questions, formulated jointly by the project participants during workshops:

Primary Questions

- Can an integrated system offer the same **supply reliability** and an opportunity to lower **operational costs**?
- Are there potential opportunities for **shared water**, and therefore demand risk management**,** in addition to shared conveyance infrastructure?
- Is there an opportunity for greater **redundancy** (and therefore cost and operational risk management) through more **flexibility** in flow pathways and connectivity to multiple sources?

Secondary Questions

- How might the integration of the two systems affect the **timing** needs for various flow pathways and source connections?
- Could **more water** be made available through an interconnected system than through two independent systems?
- What opportunities for **regional cooperation** are made possible by integrated operations?

The modeling team isolated components of the two supply systems that would be most directly affected by the two programmatic alternatives (Baseline or Interconnection) and created an array of scenarios that bounded the opportunities for benefits to both TRWD and DWU. In other words, scenarios were selected to bracket results with an upper and lower bound so that any additional refinements to this analysis will produce results that fall within the bounds identified here. Using these analyses and the team's water resources planning experience, advantages and disadvantages to interconnection were identified in terms of **operational costs** (see Section 3 for capital and lifecycle cost analyses)**, water sharing and timing,**

redundancy, flexibility, and regional cooperation. The following sections describe the modeling approach and conclusions drawn from this analysis.

2.2 Modeling Approach

A detailed modeling plan memorandum was developed in November 2007. This section is intended to provide an overview of the final modeling approach, which followed the original plan with minor adjustments, by briefly discussing tools, techniques, and guidelines. In this way, the results can be understood in their appropriate context.

To isolate components of the two supply systems that would be most directly affected by the two programmatic alternatives (Baseline or Interconnection), and to avoid unnecessary detail associated with subsystems less directly affected, the system was bounded as shown in **Figure 2-1** for modeling purposes. Because not every DWU and TRWD demand node is included in the model, total water user group demand was apportioned between model nodes in the following way:

- **DWU**: The total demand on the modeled system, at either Joe Pool Lake or the Southeast WTP, was Dallas' contracted amount from Lake Palestine, 102 mgd. This isolated the direct impacts of Dallas demand on the conveyance alternatives.

- **TRWD**: Projected demands at each node were extracted from the RiverWare model. To approximate the demand from external nodes on water within the modeled system, the TRWD RiverWare model was used to simulate the West Fork system. These external node demands are initially satisfied by water originating in the West Fork. Water from the modeled system is also delivered to Eagle Mountain Lake.

  West Fork supply is capped by a contractual limitation for normal and drought conditions applicable to the City of Fort Worth. Demand in the West Fork that is not satisfied by West Fork flows is supplied from the bounded system in the optimization model. Water to satisfy monthly targets in Lake Arlington, as well as maintaining minimum conservation pool level at Lake Benbrook; also implicitly represent an internal demand on system water.

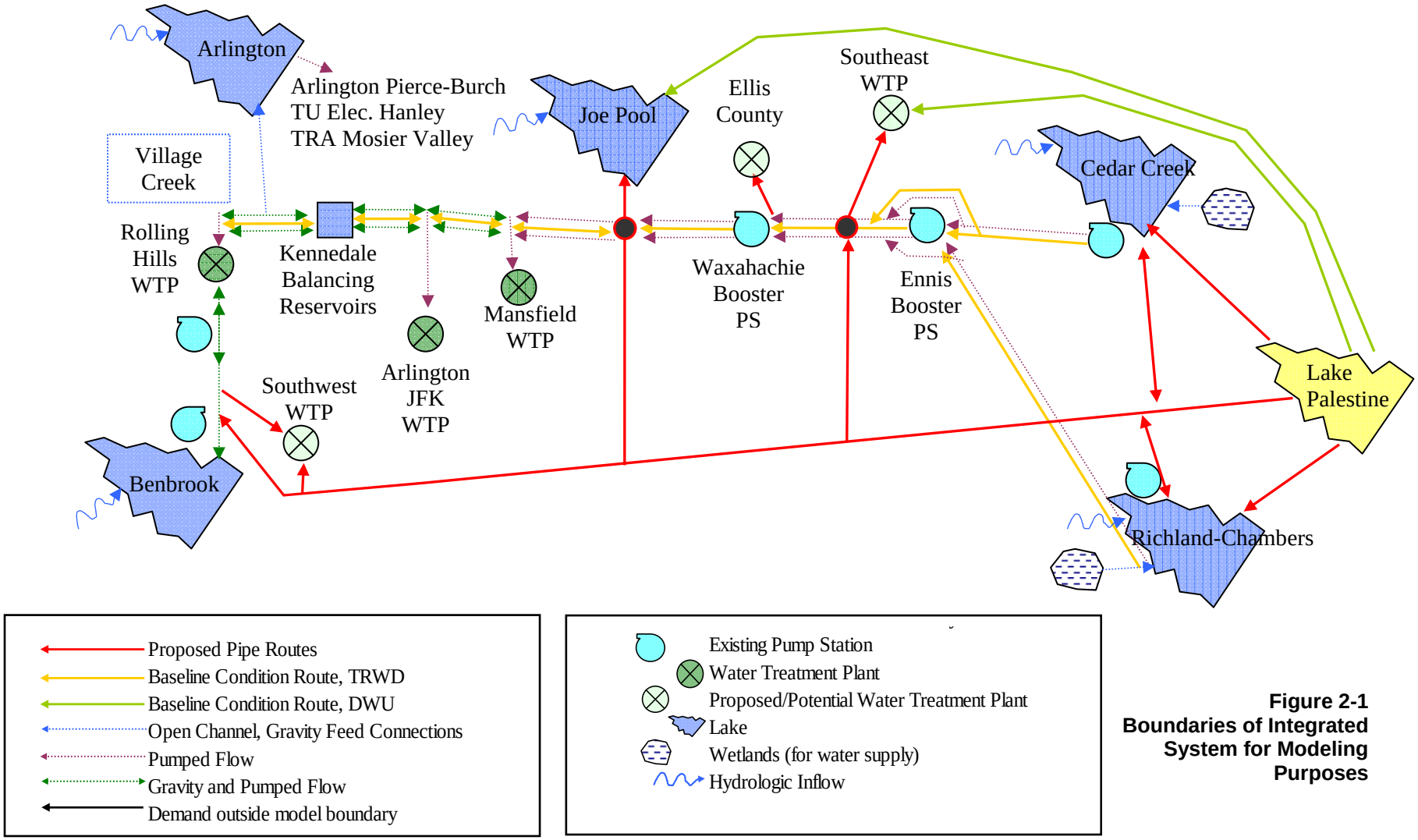


Figure 2-1
Boundaries of Integrated System for Modeling Purposes

- **Ellis County**: Projected demands for Ellis County were based on a combination of Region C 2006 Water Plan projections and the current Region C Four County Study conducted by Freese & Nichols, Inc. These demands were supplied by water available in the bounded system (generally TRWD water in the modeled scenarios).

In addition to the existing infrastructure within its boundaries, the model also included certain TRWD projects that are in the development or construction phase, or have a high probability of being constructed. These included the planned constructed wetlands at Richland-Chambers and Cedar Creek Reservoirs, the recently completed Eagle Mountain Connection from the Rolling Hills Pump Station, and the future Fort Worth Southwest Water Treatment Plant.

In general, the model was formulated on three basic tenets, described in more detail in the sections below:

- Water distribution priorities and cost calculations establish a basis for **comparison**, **not allocation** between the two entities.
- The model was formulated to focus on opportunities and costs.
- Existing operating rules were suspended (except as discussed in section 2.2.3) and the optimization program was used to suggest effective operational practices and priorities.
- The model relied on existing data sources and models (such as TRWD's RiverWare model).

2.2.1 Water Distribution and Cost Calculations

Because the purpose of this modeling was to compare Baseline and Interconnected scenarios, modeling protocols were established to provide commonality between scenarios. These protocols did not represent actual operating agreements or allocate operational costs to individual entities. Instead, they established priorities for water distribution so that the modelers could experiment with the potential for water sharing and operational cost reduction. Results indicate opportunities, not designs.

A primary modeling protocol related to demand and the distribution of water. In Baseline scenarios (independent systems), DWU's demand and allocation from Lake Palestine were 102 mgd at all times and there was no access to TRWD supplies; though the supply reliability of the DWU raw water delivery system will decrease over time as additional water supplies are required, the overall Dallas system was not modeled (in order to emphasize the elements most directly affected by interconnection) and only the 102 mgd from Lake Palestine was included. In a Baseline scenario therefore, DWU always received 102 mgd and the model was used to optimize operating costs. In the Baseline TRWD scenario, it had sole access to its

supplies and the model considered the entire TRWD system (portions of which are only external demands to the pieces modeled in detail). The model was therefore used to calculate operating costs and supply reliability decreases over time as additional water supplies are required.

In Interconnected modeling scenarios, the model considered the potential for water delivery from Lake Palestine or any portion of the TRWD system to be the same. The purpose of the model was to therefore explore the potential for cost savings, redundancy, water sharing, and etc. by optimizing in a two-step process – first the reliability of deliveries to TRWD and DWU, and second optimizing the operational costs of that "highest reliability" run by iterating on alternative delivery pathways.

The first step required "prioritization" of deliveries to three entities: TRWD, DWU, and Ellis County. Because interconnection presents no advantage to DWU if it can no longer access the 102 mgd available in an independent system, the model ensured delivery of the full 102 mgd to DWU. This also assumes that the DWU demand does not gradually increase but rather is the entire 102 mgd from Lake Palestine. Because interconnection presents no advantage to TRWD if supply reliability is lower in an integrated system than an independent system, the model then optimized TRWD's reliability, which will still decrease over time because additional water supplies were not added to the model at the decade they are required in the future; the purpose was therefore to ensure that the hydraulic capacity is available to at least match the reliability it would produce under baseline conditions, not to ensure 100% reliability in the future. After these two supplies were optimized, the model allocated additional water supplies to Ellis County.

2.2.2 Primary Focus on Opportunities and Costs

The model was formulated to help identify opportunities for operational cost savings (see Section 3for capital and lifecycle cost analyses), water sharing and timing, redundancy, flexibility, and regional cooperation associated with an interconnected system. To fully explore the potential for such a system, most existing operating rules were suspended and the model employed an optimization program to route water through the system segments in a manner that would minimize deficits at demand nodes, and to do so at the lowest estimated operating costs. The system was constrained by pipeline capacities, reservoir storage, and water availability, and conveyance costs were computed on a monthly basis for each reach in the system (as shown in **Figure 2-1**).[1]

2.2.3 Simplified Operating Rules

The optimization program was used to suggest effective operational practices and priorities (such as when to draw from Lake Palestine, for example). Though the operating rules of the existing system were not enforced[2], the following operating

[1] See section 1.4.1 for limitations to the integrated operations model.
[2] This was done to avoid the potentially artificial restrictions of applying existing operating protocols to an integrated system that as yet does not exist.

rules were used in an effort to maintain general continuity with well-established existing protocols:

- Flow between points connected by more than one pipeline was divided equally between the pipes (on a capacity percentage basis).
- Existing conservation pool limits were enforced.
- Monthly minimum targets elevations for Lake Arlington were enforced. (540 feet from June- September, 535 feet October – May). Other reservoirs were operated within their specified conservation pools. These targets were found to have only a minimal influence on overall results.
- The model allowed scenarios to be formulated with or without the existing permitted yield constraints on Cedar Creek, Richland-Chambers, and Benbrook Reservoirs (these constraints accounted for contributions from proposed TRWD wetlands to Richland-Chambers and Cedar Creek Reservoirs). Pass-through water from Lake Palestine was also added to existing permitted yield constraints for Richland-Chambers and Cedar Creek where applicable. TRWD indicated that sedimentation rates projected in the Region C planning process for TRWD reservoirs appear to be overstated and actual rates will have a negligible effect on yield. As a result, sedimentation in the reservoirs was not accounted for in the optimization model.
- Holly WTP and Eagle Mountain WTP were supplied water from both the modeled East Texas system and the West Fork Trinity River. The City of Fort Worth, by special conditions in their water rights, was limited to take no more than 100,000 acre-feet per year from the West Fork. During drought conditions, defined as when the West Fork reservoirs (Lake Bridgeport, Lake Worth, and Eagle Mountain Lake) are at less than 50% capacity, the limit was reduced to no more than 46,000 acre-feet per year. These limits were enforced within the model by exporting the demand delivered by the West Fork to each WTP from the RiverWare model, then applying the remainder of the total projected demand for each WTP to the appropriate node in the model.

2.2.4 Reliance on Existing Models

Monthly demand values for each TRWD node within the model were extracted directly from the existing TRWD RiverWare model. Likewise, the hydrologic inflows to each reservoir within the bounded system were extracted directly from RiverWare. Because the DWU demand is bounded by the Lake Palestine yield, no additional data was required from an existing DWU system model.

2.3 Array of Operational Scenarios

The model allowed the formulation of a variety of scenarios, as shown on the screen capture of the model's interface screen in **Figure 2-2**. Various segments of the conveyance infrastructure were activated or deactivated for each scenario, allowing

the model to examine how best to utilize each pathway, and which ones would likely be most cost effective. Each scenario spanned a seven-year period on a monthly timestep and water availability was selected to represent comparatively normal conditions, or the drought of record. Hydrology was superimposed on future demand projections for TRWD and DWU through 2060.

The nearly endless array of possible scenarios was limited to those that clearly provided decision support regarding advantages or disadvantages of investing in infrastructure jointly or separately. These scenarios revealed opportunities for operational cost reductions, water sharing and timing, redundancy, and flexibility. These opportunities were tested for two conditions imposed on the model: permitted yield constrained and system operations. In the permitted yield constraint models (somewhat akin to a "firm yield" condition), the system is limited by conveyance capacity and all water supplies are limited by the lesser of their contracted/permitted amounts or firm yield amounts as defined by TCEQ. In the system operations condition, the model was constrained by lake levels, conveyance capacity and climate, but not by contracted/permitted values.

The following list explains the primary variables used to formulate each scenario:

- Conveyance Alternative: the four conveyance alternatives in **Table 1-1** were used to distinguish costs and benefits between baseline and interconnected alternatives.

- Optimization Objectives: Most scenarios were optimized to yield the highest supply reliability, and then, using those reliability targets, optimized to yield the lowest operational cost. In some experimental scenarios, the model was not optimized for cost because it did not contribute information needed to make decisions based on those particular scenarios.

- To test the impact of the TRWD constructed wetlands, capacity was set to full permitted amounts or zero.

- DWU demand: in experimental scenarios used to test the potential for water sharing, the DWU demand was prioritized behind TRWD and Ellis County and set at 1,000 mgd (essentially unlimited) and set at 0 mgd to test water sharing potential for TRWD.

- Application of existing permitted supply constraints. The model allowed scenarios to be formulated with or without the existing permitted yield constraints on Cedar Creek, Richland-Chambers, and Benbrook Reservoirs.

- Demands could be set by decade between 2010 and 2060.

- Hydrologic Condition: Each alternative could be tested during drought or normal hydrologic conditions.

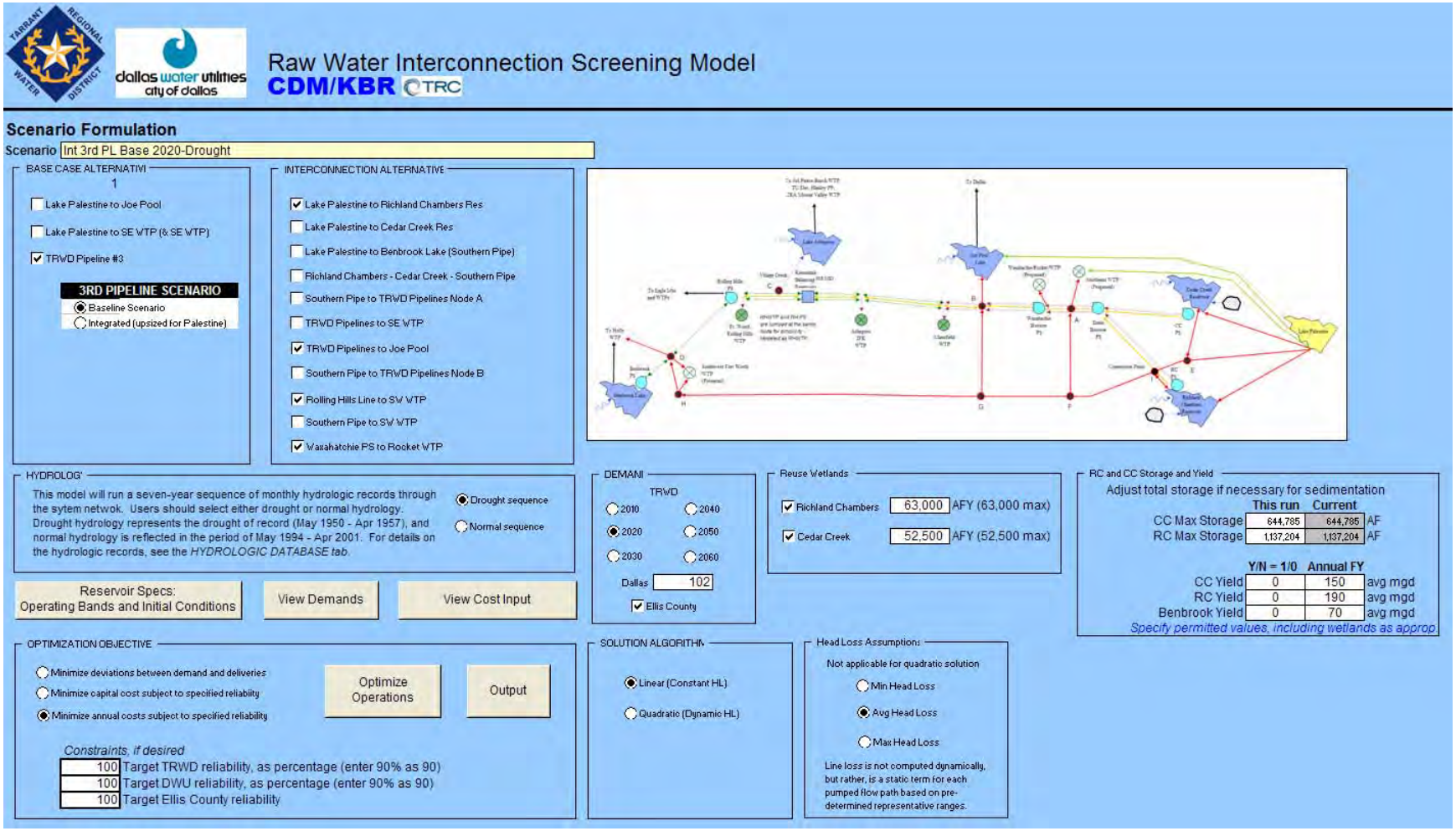


Figure 2-2
Scenario Formulation Interface

2.4 Conclusions from Integrated Operations Analysis

The purpose of this analysis was to identify opportunities for benefits, or potential disadvantages, to both TRWD and DWU through integrated operations of the raw water transmission systems from Lake Palestine, Richland-Chambers Reservoir, and Cedar Creek Reservoir. This comparison of Baseline Alternatives 1 and 2 with Interconnection Alternatives 3 and 4 (see **Table 1-1**) was driven by a system operations model and the team's water resource planning experience. This model was formulated as a decision-support system that permitted the user to create an array of scenarios that help answer a series of primary and secondary questions, formulated jointly by the project participants during workshops:

In this context, we can conclude the following regarding operating costs, water sharing and timing, redundancy, flexibility, and regional cooperation:

2.4.1 Operating Costs

As illustrated in **Figure 2-3**, the integrated operations modeling shows that operating costs within the bounded system (see **Figure 2-1**) are lower in interconnected alternatives as compared to baseline alternatives. This opportunity for operational cost savings is more pronounced in the near term and decreases over time as the difference between interconnected and independent operations is minimized. This near-term savings is attributed to the fact that the full amount of DWU water supply from Lake Palestine is not required immediately. (DWU access to the TRWD supply system could extend the need to connect the Lake Palestine supply to each system.)

2.4.2 Water Sharing and Timing

The integrated operations modeling found that there is opportunity to make extra water available to water user groups via an interconnected system. The analysis suggests that even under drought conditions in 2020, approximately 80 additional mgd could be available. This result is based on three modeling protocols: 1) water availability is limited by existing TRWD permits (for Richland-Chambers, Cedar Creek, and the planned wetlands); 2) DWU demand is equal to the contracted amount in Lake Palestine (102 mgd); and 3) conveyance is limited by the capacity of existing and planned TRWD conveyance facilities.

This result also confirms that Lake Palestine supply will be required prior to 2020 if the DWU demand reaches 102 mgd (though not all of it will be required immediately and dependence upon it as a source could conceivably be phased). Additions to conveyance capacity could be phased through 2030. TRWD requires water supply in addition to sources already included in the model, such as the reuse wetlands, between 2030 and 2040 (based on existing permit constraints and projected demands).

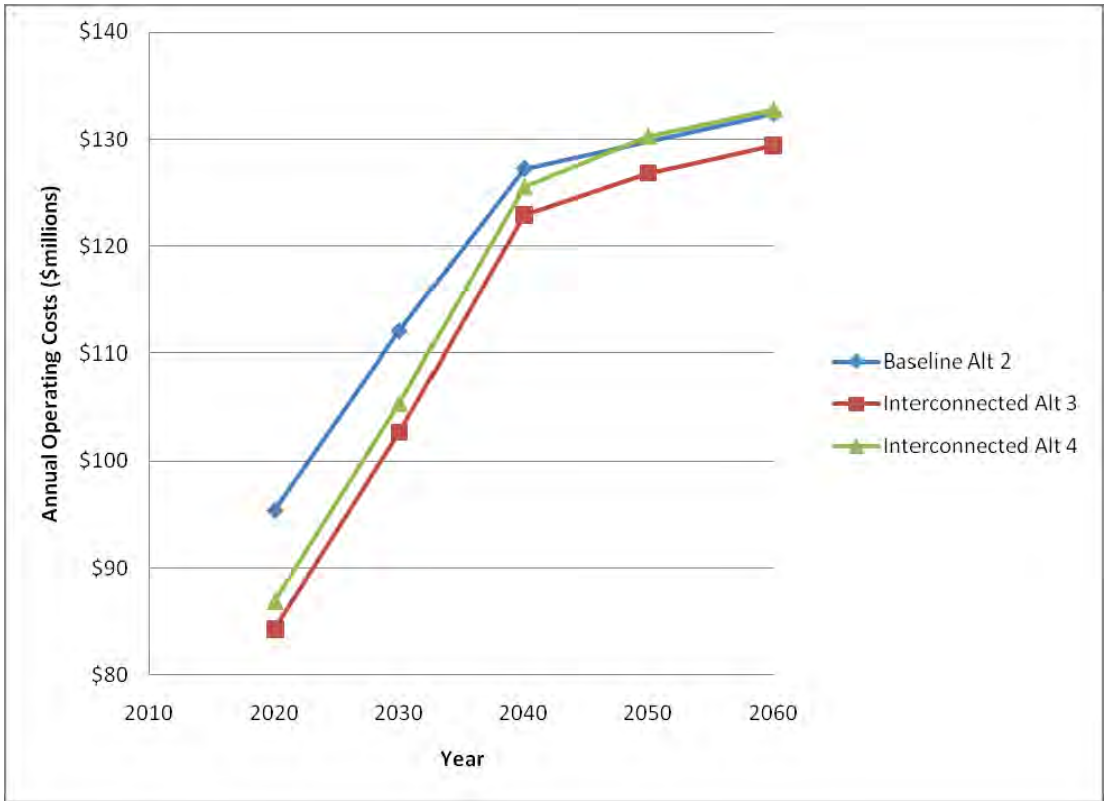


Figure 2-3
Summary of Operational Cost Opportunities Under Drought Conditions

Interconnection also provides the opportunity for TRWD to use the 102 mgd from Lake Palestine. This water sharing may be useful in an emergency situation or in a localized drought condition that causes deficit in the TRWD system while excess is available to DWU. This opportunity to share water between the two water providers is also a method of demand risk management to mitigate the effects of unforeseen demand growth patterns in the TRWD or DWU systems.

By the year 2030, any configuration of the system becomes supply limited, and reliability predictions during severe droughts would be roughly equivalent among configurations. However, during normal hydrologic periods, extra supply is available through 2060 in an interconnected system, though TRWD may have conveyance limitations to accessing the water. The analysis also indicates that the TRWD system can support sustained withdrawals above the current permitted levels. In other words, supply is limited by the permitted amounts, not water availability.

With an interconnected system, any additional water above projected demands would conceivably be available to any water user group, provided that conveyance capacity would be adequate. With separate systems, this water would not be available to DWU and TRWD and its customers would not benefit from potential sales or trades of water above projected TRWD customer demands. With an interconnected system, there is also the possibility of bringing other, currently independent sources (such as

DWU reuse water) and new water supply sources (Toledo Bend, Oklahoma, etc.) into the interconnected system to enhance the potential for water sharing.

To satisfy the DWU demands as they are represented in the model, the full yield of Lake Palestine (102 mgd) is needed immediately if the two systems remain separate. If conveyance systems are interconnected, use of Lake Palestine could ramp up gradually (assuming TRWD water supply in excess of projected demands could help satisfy DWU demand). This offers significant benefits with respect to phased infrastructure that are not available with separate systems.

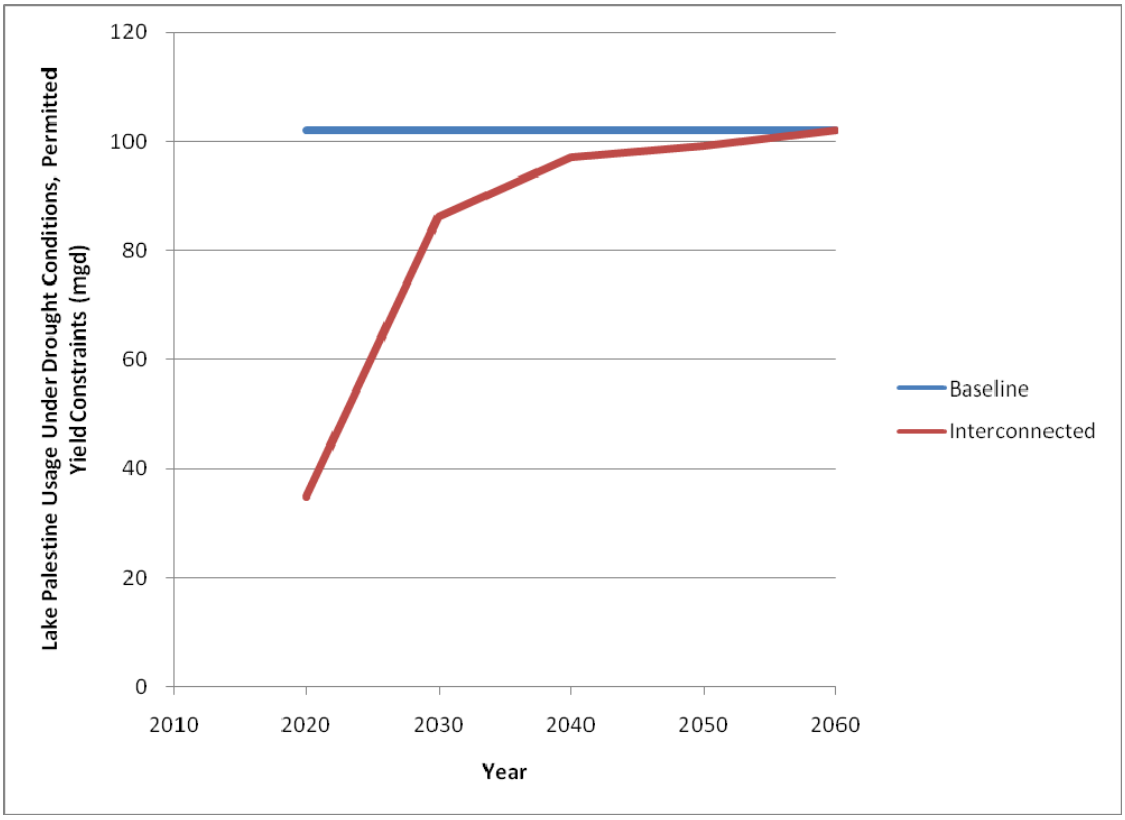


Figure 2-4
Potential Impact on Lake Palestine Timing (Assuming DWU Demand Constant at 102 mgd, Drought Conditions, Permitted Yield Constraints)

2.4.3 Redundancy

Operational redundancy is a "belt and suspenders" approach to risk management that enables the water supplier to select from multiple supply sources in times of emergency, drought, failure, etc. An interconnected supply system therefore provides more opportunity for supply and failure risk management.

In the event of a pipe failure or power outage, an integrated transmission system has more alternative flow pathways and connections to multiple water and power sources. These additional connections lower risk to the water provider. The impacts

of climatic variations are also lessened because of the diversification of reservoir locations. An interconnected system "casts a wider net" to reservoirs in different watersheds that will potentially experience drought in different times or levels of severity. Also, access to additional sources that may not be fully utilized adds supply redundancy to the system.

2.4.4 Operational Flexibility

Under prevailing ("normal") hydrologic conditions when the modeled system is not supply-limited, an interconnected system offers more operational flexibility than separate sources, since multiple flow pathways could be used to transport water. Such flexibility could be used to capitalize on advantageous opportunities for blending of sources, pump cycling schedules, system maintenance and energy management. One potential disadvantage of operations in an integrated system is the potential for increased operational complexity and the attendant new systems and protocols that must be developed to manage such a system.

The interconnected system also provides flexibility in terms of water availability. Extra supply is available through 2060 in an interconnected system and the analysis indicates that the TRWD system can support sustained withdrawals above the current permitted levels. This ability to overdraft supply sources provides flexibility to system operations, the potential for lower operating costs, and risk mitigation.

The National Water Research Institute in its November 2007 white paper entitled "Water 2010: A 'Near Sighted' Program of Water Resource Management Improvements for the Western United States" recommended system interties as its number one action item for state and local policymakers. NWRI concluded that "System interties increase the flexibility of system operators to respond to weather events, natural disasters, contaminations incidents, or the need to take water treatment or conveyance facilities temporarily off-line for repair or refurbishment……many interconnections can be planned and constructed within just a few years and at a relatively low cost."

2.4.5 Regional Cooperation

TRWD and DWU have a long history of cooperation in water supply planning, including the Texas Water Development Board regional water planning efforts initiated by the 1997 passage of Senate Bill 1 in the 75th session of the Texas Legislature. This on-going cooperation has led to this study and the potential for raw water transmission system interconnection. The interconnection of the two systems provides opportunities for benefit to both agencies by laying the groundwork for interconnecting future water supply sources (Toledo Bend, Oklahoma, etc.), increasing the portfolio of water supply options, reducing the costs of right-of-way through earlier acquisition, providing financing risk management, and compliance with TWDB planning guidelines.

The groundwork for regional cooperation in accessing future water supply options has already been laid; integrated water supply infrastructure provides additional opportunity for cost savings and will facilitate future inter-local agreements. By interconnecting the transmission system, each agency also effectively increases its portfolio of water supply options through the potential to share water and infrastructure.

Escalating costs for right-of-way acquisition (and urbanization) also point to the benefits of securing transmission routes early. This early acquisition presents an opportunity to acquire sufficient right-of-way for future joint water supplies. TRWD has recently experienced the following average costs for securing easements for several large diameter transmission system projects, costs which raise the issue of expedited acquisition of right-of-way for this and other future joint projects:

- Real estate classified as rural - $15,415 per acre.
- Real estate classified as undeveloped, planned - $33,792 per acre.
- Real estate classified as developed - $71,247 per acre.

Escalation in the cost of materials and ever increasing pressure on the financing market also point to the benefits of interconnection. Economies of scale and the ability to leverage the joint financing capacity of both agencies are benefits in integration.

Along with the other opportunities for benefits through integration, this regional cooperation is in compliance with TWDB guidelines for water supply planning. These guidelines and the TWDB planning process require this cooperation.

2.5 Summary Conclusion

From an operational perspective, the analysis supports further investigation of interconnected conveyance alternatives. Unlike separate systems, an interconnected system that routes Lake Palestine through the planned TRWD system offers reduced operating costs, cost sharing, savings due to infrastructure phasing, opportunities for water sharing, the potential for increased overall system yield and supply reliability, redundancy, and operational flexibility with respect to infrastructure scheduling and daily operations.

These results indicate a broad range of potential benefits that could be realized with an interconnected system as opposed to separate systems. Subsequent sections of this report address other factors relevant to interconnections, such as water quality, treatment requirements, environmental impacts, etc. Subsequent phases of work will establish operating protocols and cost agreements for shared conveyance and shared supply, and will address permitting needs.

Section 3
Lifecycle Cost Analysis

3.1 Purpose

The purpose of this cost analysis task was to develop a screening level/conceptual opinion of probable capital and lifecycle cost for each project conveyance alternative and to conduct a present worth economic comparison between the Baseline and Interconnection alternatives. The cost analyses represent total costs for water delivery and do not allocate costs between DWU and TRWD. The capital cost opinions presented herein are based on guidelines established by the Texas Water Development Board (TWDB) for use in regional water planning activities. The primary deviation from the TWDB guidelines is that the lifecycle cost analyses presented below consider escalation in power, operations and maintenance, and replacement costs while the TWDB guidelines specify development of a current (i.e., non-escalated) estimated annual cost for use in comparisons of alternative water management strategies.

The four project conveyance alternatives (described in **Table 1-1** and reproduced below for the reader's convenience) were compared in this cost analysis. The reader should refer to **Figures 1-4** through **1-8** for maps of pipeline routes used in each conveyance alternative.

Alternative	Description
1 (Baseline)	Independent Systems: TRWD's East Texas Third Pipeline and DWU's connection of Lake Palestine to the proposed Southeast Water Treatment Plant
2 (Baseline)	Independent Systems: TRWD's East Texas Third Pipeline and DWU's connection of Lake Palestine to Joe Pool Lake
3 (Interconnection)	Integrated System: Interconnected Third Pipeline (upsized as compared to the baseline condition) with connection of Lake Palestine to Cedar Creek Reservoir and delivery to DWU at Joe Pool Lake and TRWD's customers through the Third Pipeline
4 (Interconnection)	Integrated System: Interconnected "Southern Pipeline" - Lake Palestine delivered to the Lake Benbrook pipeline via a pipeline route to the south of the TRWD Third Pipeline route. Delivery to DWU at Joe Pool Lake and TRWD's customers through connections to the existing system and the Lake Benbrook pipeline.

Screening level/conceptual capital cost analyses for each project conveyance alternative are presented below. Background information and the results of the life-cycle cost analysis are then presented along with a discussion of the life-cycle cost analysis method. The reader should refer to section 1.4.2 for a discussion of the uncertainties and limitations associated with the development of this preliminary cost analysis and section 1.4.3 for recommendations for future cost analyses that will help refine the cost information and provide differentiation between Interconnection alternatives.

3.2 Capital Cost Analysis

The conceptual capital cost estimates for each project conveyance alternative are presented in **Table 3-1**. The table also contains the component pieces of the baseline alternatives broken down into individual capital cost estimates. The pipelines that compose these conveyance alternatives are:

TRWD Baseline Third Pipeline

- Cedar Creek to Ennis Pump Station
- Richland-Chambers to Ennis Pump Station
- Ennis Pump Station to Rolling Hills Water Treatment Plant

DWU Baseline

- Lake Palestine to Southeast WTP; or
- Lake Palestine to Joe Pool Lake

Interconnected Third Pipeline

- Lake Palestine to Cedar Creek Reservoir
- Cedar Creek Reservoir to Ennis Pump Station
- Richland-Chambers to Ennis Pump Station
- Ennis Pump Station to Rolling Hills Water Treatment Plant

Interconnected Southern Pipeline

- Lake Palestine to Lake Benbrook (Southern Route)
- Cedar Creek to Southern Pipeline
- Richland-Chambers Reservoir to Southern Pipeline
- Southern Pipeline to Joe Pool Lake Interconnect (interconnect w/TRWD Lines but effectively adjacent to Joe Pool connection)

Table 3-1
Results of Conceptual Capital Cost Analysis

Baseline Alternatives	Capital Cost (2008 basis)
Alternative 1: TRWD Third Pipeline + DWU Lake Palestine to SE WTP	$1,177,844,000
(Component 1: DWU Lake Palestine to SE WTP)	(548,949,000)
(Component 2: TRWD Third Pipeline)	(628,894,000)
Alternative 2: TRWD Third Pipeline + Lake Palestine to Joe Pool Lake	$1,303,360,000
(Component 1: DWU Lake Palestine to Joe Pool Lake)	(674,466,000)
(Component 2: TRWD Third Pipeline)	(628,894,000)
Interconnection Alternatives	
Alternative 3: Interconnected Third Pipeline	$1,083,966,000
Alternative 4: Interconnected Southern Pipeline	$1,355,279,000

3.3 Lifecycle Cost Analysis

Results from the screening level life-cycle cost analyses are shown in **Table 3-2** and **Table 3-3**. **Table 3-2** presents results on a total cost basis over 50 years, a Present Value basis (2008 dollars), and on a unit cost basis (i.e. cost per 1,000 gallons). The comparison of life-cycle costs for each project conveyance alternative is presented in **Table 3-3**.

Each of the primary variables in these lifecycle calculations are described in the sections below **Table 3-4**. These variables were: debt service and the discount rate, renewal and replacement costs, operational (energy) costs, and operations and maintenance.

Unit costs are specifically excluded from these results because only a portion of the DWU and TRWD transmission systems were modeled and because costs and water volumes were not allocated between the two entities in this study (this analysis will be necessary in subsequent phases).

Table 3-2
Lifecycle Cost Analysis Results

Baseline Alternatives	Total Cost (50-year Life)	Present Value Cost
Alternative 1: TRWD Third Pipeline + DWU Lake Palestine to SE WTP	$6,043,044,000	$2,462,651,000
(Component 1: DWU Lake Palestine to SE WTP)	(2,738,178,000)	(1,198,104,000)
(Component 2: TRWD Third Pipeline)	(3,304,866,000)	(1,264,547,000)
Alternative 2: TRWD Third Pipeline + Lake Palestine to Joe Pool Lake	6,774,762,000	$2,776,834,000
(Component 1: DWU Lake Palestine to Joe Pool Lake)	(3,469,896,000)	(1,512,287,000)
(Component 2: TRWD Third Pipeline)	(3,304,866,000)	(1,264,547,000)
Interconnection Alternatives		
Alternative 3: Interconnected Third Pipeline	5,578,924,000	2,238,879,000
Alternative 4: Interconnected Southern Pipeline	6,306,874,000	2,740,189,000

*Note that interconnected alternatives include delivery to Joe Pool Lake, not the SEWTP.

Table 3-3
Lifecycle Cost Differences – Comparison of Project Conveyance Alternatives

Interconnection Alternative	Comparison Baseline Alternative	Total Cost Difference	Present Value Cost Difference
3 (Interconnected Third Pipeline)	1 (w/ Pal. to SE WTP)	$464,120,000	$223,771,000
3 (Interconnected Third Pipeline)	2 (w/ Pal. to Joe Pool)	1,195,837,000	537,954,000
4 (Interconnected Southern Pipeline)	1 (w/ Pal. to SE WTP)	$-263,830,000	$-277,538,000
4 (Interconnected Southern Pipeline)	2 (w/ Pal. to Joe Pool)	467,887,000	36,644,000

*Note that interconnected alternatives include delivery to Joe Pool Lake, not the SEWTP.

3.3.1 Discount Rate

The discount rate is calculated as the cost of debt for the organization that will build the project and is then adjusted as needed to account for elements of risk unique to each project scenario. Because all variables in this life-cycle cost analysis are costs (as opposed to investments), a higher discount rate is favorable; additional risk factors decrease the discount rate as opposed to the traditional increase that would typically occur in an "investment scenario". For the DWU Baseline alternatives, the cost of debt was assumed to be 4.88%, which is equal to the simple average of the interest rates for the series of bonds in the 2006 Waterworks and Sewer System Revenue Refunding and Improvement Bonds from the City of Dallas 2006 Annual Report. For the TRWD Baseline alternative, the cost of debt was assumed to be 5.07%, which is equal to the TRWD 2006 Series Water Revenue Bonds' average annual interest rate. For the Interconnected alternatives, 4.97% was used, which is the simple average of the cost of debt for DWU and TRWD.

With the discount rate set equal to the cost of debt quoted above, risk factors were then identified and quantified in terms of a percentage reduction in the discount rate. The following risk factors were quantified based on the team's expert opinion:

- Political Risk: As a consequence of DWU and TRWD having to coordinate efforts in an interconnected alternative, both of these alternatives were deemed to have some political risk resulting from a potential delay in construction of one year. The cost of this political risk was quantified as 0.20 percent.

- Construction Delay: A reduction in the Interconnected Southern Pipeline alternative discount rate was applied to account for the potential delays associated with real estate acquisition (e.g., easements for pipelines). It was assumed that pipeline construction could begin prior to and concurrent with acquisition of all required easements. This risk was quantified as 0.40 percent to reflect a potential two-year delay in construction. Similarly, a reduction in the DWU Baseline alternatives' discount rate was quantified as 0.30 percent to represent an 18 month delay associated with procuring right-of-way easements. This delay is assumed to be less than the delay for the Interconnected Southern Pipeline alternative because of the relatively shorter pipeline length required for the DWU Baseline alternatives.

The discount rates applied in the 50-year life cycle cost analysis for each component of the project conveyance alternatives are summarized below in **Table 3-4**.

Table 3-4
Discount Rates

Components of Baseline Alternatives	Discount Rate	Interconnection Alternatives	Discount Rate
Lake Palestine to Joe Pool Lake		Interconnected 3rd Pipeline	
Cost of Debt	4.88%	Cost of Debt	4.97%
Cost of Delay	-0.30%	Political Risk	-0.20%
Total	4.58%	Total	4.77%
Lake Palestine to SE WTP			
Cost of Debt	4.88%	Southern Pipeline	
Cost of Delay	-0.30%	Cost of Debt	4.97%
Total	4.58%	Political Risk	-0.20%
TRWD Third Pipeline		Cost of Delay	-0.40%
Cost of Debt	5.07%	Total	4.37%
Total	5.07%		

3.3.2 Renewal and Replacement Costs

Some infrastructure elements will require replacement during the 50-year life-cycle of the system. The renewal and replacement analysis captured this element of cost for each project scenario. An example of renewal and replacement cost assumptions applied to the Interconnected Third Pipeline is shown in the **Table 3-5**.

Table 3-5
Renewal and Replacement: Average Years to Renewal

	Channel Dam / Intake	Pump Stations (Elec/Mech Equipment)	Tanks	Pipelines	Disinfection /Surge Control
Average Years to Renewal	50	30	50	50	25

It was assumed that only the pump stations and disinfection/surge control equipment are likely to require replacement during the 50-year project life-cycle. Estimated equipment life was obtained from the TCEQ System of Accounts, June 1999. It was assumed that 40 percent of the original capital costs will be required to replace certain elements of the pump station facilities and that the remaining 60 percent represents structural components, which have a significantly longer life expectancy. The pump station replacement cost was increased by another 20 percent to act as a contingency for unquantified pump station renewal costs.

For this analysis, the disinfection/surge control equipment was assumed to require 100 percent replacement and an additional 20 percent was added for contingency. The renewal and replacement costs for both pump stations and disinfection/surge control equipment were then inflated by the projected long-term U.S. inflation rate to estimate the capital costs at the time of renewal or replacement.

3.3.3 Energy Costs

Energy costs were calculated as the product of an assumed energy rate and the usage for each project conveyance alternative. The energy usage was based on the system operations model (see Section 2), which calculated operational costs (energy) in kilowatt hours (kWh) over seven years of assumed hydrologic conditions, either drought or normal. For the life-cycle cost analysis, energy usage during normal hydrologic conditions was used to represent average conditions over the 50-year life-cycle.

The energy rate was based on data from the Electric Reliability Council of Texas (ERCOT) for electric power delivered within the ERCOT North Texas Zone; an energy rate of $0.084/kwh was used in this analysis .This rate was not escalated over the course of the 50-year lifecycle of each project based on the US Department of Energy Annual Energy Outlook 2008 Energy Prices by Sector and Source forecast.

3.3.4 Operations and Maintenance Costs

Operations and maintenance (O&M) costs for each project alternative were calculated in accordance with Texas Water Development Board (TWDB) guidelines for regional water supply planning. TWDB guidelines provide an estimated fixed percentage of construction cost for various types of facilities to estimate O&M costs. The construction cost is the capital cost for each facility type and does not include financing or other related costs.

O&M costs were escalated over time using the inflation rate, projected as the long-term U.S. inflation rate according to the U.S. Bureau of Labor Statistics. Its intent was to capture the increase in wages and other costs associated with operations and maintenance. Energy costs were not included in this O&M cost calculation because they were considered independently. An example of the estimated annual O&M costs for the Interconnected Third Pipeline alternative is shown in **Table 3-6**.

Table 3-6
Operations and Maintenance as a Percentage of Construction Cost

	Channel Dam / Intake	Pump Stations	Tanks	Pipelines	Disinfection / Surge Control
O&M as % of Construction Cost	1.50%	2.50%	2.50%	1.00%	2.50%

3.4 Lifecycle Cost Analysis Conclusions

The purpose of the cost analysis task was to develop a screening level/conceptual opinion of probable capital and lifecycle cost for each project conveyance alternative and to conduct a present worth economic comparison between the Baseline and Interconnection alternatives. Results were presented above in **Tables 3-2** and **3-3** and show that there are opportunities for significant cost savings through an integration of the raw water transmission systems to deliver Lake Palestine water to DWU and TRWD.

Delivering water through an Interconnected Third Pipeline has potential Present Value, 50-year life-cycle cost savings between approximately $220,000,000 and $540,000,000.

The Interconnected Southern Pipeline alternative has potential Present Value, 50-year life-cycle cost savings when compared to Alternative 2 (baseline with delivery to Joe Pool) but increased cost when compared to Alternative 1 (baseline with delivery to SE WTP). However, because the Interconnected Southern Pipeline delivers water to Joe Pool Lake and not the SE WTP, the most direct comparison is between the Interconnected Southern Pipeline and Alternative 2, which results in an approximate $36,600,000 savings. Subsequent phases of this feasibility assessment will consider other potential benefits from the Southern Pipeline, such as supply risk reduction and right-of-way acquisition for future supplies. For example, TRWD has recently experienced the following average costs for securing easements for several large diameter transmission system projects:

- Real estate classified as rural - $15,415 per acre.
- Real estate classified as undeveloped, planned - $33,792 per acre.
- Real estate classified as developed - $71,247 per acre.

These costs raise the issue of expedited acquisition of right-of-way (e.g. in the Southern Pipeline route) to manage the availability and cost of acquisition for this and future water supplies. Also, phasing could also result in significant reduction of costs associated with the Interconnected Southern Pipeline due to the potential to defer development of transmission facilities required to deliver water to Lake Benbrook.

Section 4
Constraints Analysis

A preliminary facility siting constraints analysis was performed to identify potential fatal flaws to locating water transmission facilities along select pipeline corridors and to make a comparison between project conveyance alternatives. The data collected for the constraints analysis will also have use during subsequent phases of engineering. The preliminary constraints analysis was accomplished using publicly available data from secondary sources (no field data collection). A database of constraint data and aerial photography was developed using Geographic Information System (GIS) applications software. Using this spatial data, a team of subject matter experts identified potential facility siting constraints in three categories: land use, environmental, and technical (engineering). After relevant data was compiled and analyzed for each potential constraint, subject matter experts rated the potential for impact as "High", "Medium", "Low", or "No Impact" and the team then came to a consensus on the overall potential impact on each transmission corridor.

The facility siting constraints analysis is summarized in the Alternatives Evaluation Matrix (AEM). This tool is simply a tabulation of the constraints within the three impact categories, beginning with the generalized "Impact Category", which is then broken down into "Evaluation Criteria", which are comprised of "Components". Basic facility data is also included in the AEM to identify each alternative and quantify dimensions and capacities of water transmission infrastructure.

This section summarizes the constraints analysis. First is a description of the infrastructure components in each of the four scenarios. Next is a discussion of the Alternatives Evaluation Matrix (AEM). Lastly, preliminary findings and consensus evaluations are presented.

4.1 Description of Alternatives

Like all other project analyses, the constraints analysis compared four project conveyance alternatives, which are listed in **Table 1-1** and reproduced here for the reader's convenience.

Alternative	Description
1 (Baseline)	Independent Systems: TRWD's East Texas Third Pipeline and DWU's connection of Lake Palestine to the proposed Southeast Water Treatment Plant
2 (Baseline)	Independent Systems: TRWD's East Texas Third Pipeline and DWU's connection of Lake Palestine to Joe Pool Lake
3 (Interconnection)	Integrated System: Interconnected Third Pipeline (upsized as compared to the baseline condition) with connection of Lake Palestine to Cedar Creek Reservoir and delivery to DWU at Joe Pool Lake and TRWD's customers through the Third Pipeline
4 (Interconnection)	Integrated System: Interconnected "Southern Pipeline" - Lake Palestine delivered to the Lake Benbrook pipeline via a pipeline route to the south of the TRWD Third Pipeline route. Delivery to DWU at Joe Pool Lake and TRWD's customers through connections to the existing system and the Lake Benbrook pipeline.

A brief description of the facilities used in each alternative, and the basis for their selection, follows. The reader should refer to **Figures 1-4 through 1-8** for mapping of the infrastructure components that make up each of the four project conveyance alternatives.

DWU Baseline – Palestine to Southeast WTP

DWU's primary baseline alternative for connecting Lake Palestine to the DWU service area is to construct a pipeline directly from Lake Palestine to the site of the proposed Southeast Water Treatment Plant (WTP) in Hutchins, TX. This baseline alternative consists of three principal components:

- An intake pump station at Lake Palestine;
- A single 84 inch pipeline from Lake Palestine to the Southeast WTP; and
- A booster pump station at Murchison, TX.

Almost two decades have passed since planning level studies were completed for this project alternative, which at the time included site selection for the Southeast WTP and the intake at Lake Palestine, and an alignment study for the transmission pipeline (see Lake Palestine Utilization and Pipeline Alignment Study, by Dannenbaum Engineering Corporation, June 1989). The recommended pipeline alignment and locations for the intake and WTP were used in this constraints analysis.

According to DWU staff, the Southeast WTP location recommended in the previous study is favorable for interconnection with the DWU distribution system. However, the WTP site is adjacent to two intermodal transportation facilities that will make development of a facility at that site difficult. The location of the WTP could be moved longitudinally along the previously studied pipeline alignment but suitable alternative sites are not readily available.

DWU Baseline – Lake Palestine to Joe Pool Lake

An alternative stand-alone baseline project for DWU is to construct a pipeline from Lake Palestine to Joe Pool Lake. This baseline alternative consists of three principal components:

- An intake pump station at Lake Palestine;
- A single 84 inch pipeline from Lake Palestine to Joe Pool Lake; and
- Two booster pump stations.

This baseline alternative was proposed for evaluation by DWU due to potential limitations to the original proposed site for the Southeast WTP. Delivery of Lake Palestine water to Joe Pool Lake offers potential advantages in terms of development of a new WTP in proximity to portions of the DWU service area where additional supplies are needed. A WTP site near Mountain Creek Lake would provide treatment capacity in close proximity to the high, medium, and low pressure planes of the DWU service area. Alternatively, Lake Palestine water supplies could be transferred from Joe Pool Lake to the existing DWU Bachman WTP (see Section 8 of this report), thereby freeing up raw water supplies from Lake Lewisville and Lake Ray Roberts for expansion of the DWU Elm Fork WTP.

Because the corridor between the Southeast WTP site and Joe Pool Lake is largely urbanized, the pipeline alignment for this baseline alternative would not follow the same route proposed for delivery to the Southeast WTP. Instead, it would follow a more southerly route from Lake Palestine to Joe Pool Lake, passing between the Richland-Chambers and Cedar Creek Reservoirs.

TRWD Baseline – Third Pipeline

TRWD's baseline alternative is to construct additional conveyance capacity to deliver water from Richland-Chambers Reservoir and Cedar Creek Lake to as far west as Rolling Hills WTP and intermediate delivery points. This "East Texas Third Pipeline" would share existing right-of-way with two existing TRWD pipelines. TRWD's baseline alternative consists of six principal components:

- Additional intake capacity at Richland-Chambers Reservoir and a 60 inch pipeline to the existing TRWD Ennis Booster Pump Station;
- Additional intake capacity at Cedar Creek Lake and a 72 inch pipeline to the Ennis Booster Pump Station;
- A single 84 inch pipeline to carry the combined additional flow from the Ennis Booster Pump Station to existing TRWD balancing reservoirs at Kennedale;
- A bi-directional 96 inch pipeline from the Kennedale balancing reservoirs to the Rolling Hills WTP;

- Additional pumping capacity at the existing TRWD pump stations at Ennis and Waxahachie; and

Because of the potential to share existing pipeline right-of-way and booster pump station infrastructure, the Third Pipeline is thought to be the lowest cost baseline alternative for TRWD to deliver additional raw water from its East Texas reservoirs

Interconnected Third Pipeline

This alternative would deliver raw water supplies from Lake Palestine through an interconnected system to both TRWD and DWU. This alternative includes the same principal components as the above TRWD baseline alternative, up-sized for the additional flow from Lake Palestine, and the following additional components:

- An intake pump station at Lake Palestine;
- A single 72 inch pipeline from Lake Palestine to Cedar Creek Reservoir; and
- A turnout from the Third Pipeline to deliver water to Joe Pool Lake.

Interconnected Southern Pipeline

This project conveyance alternative was considered as an option to the Interconnected Third Pipeline because of the potential benefits to system reliability (three pipelines in one shared transmission corridor may increase the risk of failure for all three lines and therefore lower the reliability of the East Texas supply), right-of-way acquisition, and phasing. This alternative would provide an alignment and reserve right-of-way for the transmission of future water supplies from East Texas and consists of the following principal components:

- An intake pump station at Lake Palestine;
- A single 108 inch pipeline from Lake Palestine to Benbrook Lake;
- A bi-directional 66 inch interconnection pipeline from Richland-Chambers Reservoir;
- A bi-directional 72 inch interconnection pipeline from Cedar Creek Lake;
- A 108 inch interconnection pipeline to Joe Pool Lake;
- Three booster pump stations.

The Interconnected Southern Pipeline would pass between Richland-Chambers and Cedar Creek Reservoirs. Interconnections with both reservoirs would provide flexibility to deliver Lake Palestine water into these reservoirs for temporary storage or to add supply from these lakes to the joint transmission line. These interconnects would increase operational flexibility and yield reliability.

Pipeline Corridors

At this stage of the Lake Palestine Project Viability Assessment, pipeline alignments were defined broadly, in spatial terms. The constraints analysis was performed on a two-mile wide corridor for each pipeline segment around an assumed centerline. Constraints data was analyzed to indicate the potential for utility, environmental, and other conflicts within each corridor rather than along the assumed centerline. The assumed centerline was defined by the project team by first assuming the shortest route between the beginning and end points, and then deviating from that line in consideration of apparent conflicts (e.g., towns, major water courses, road crossings, etc.). **Figure 4-1** shows an approximate centerline longitudinal surface elevation profile for some of the primary alternative routes.

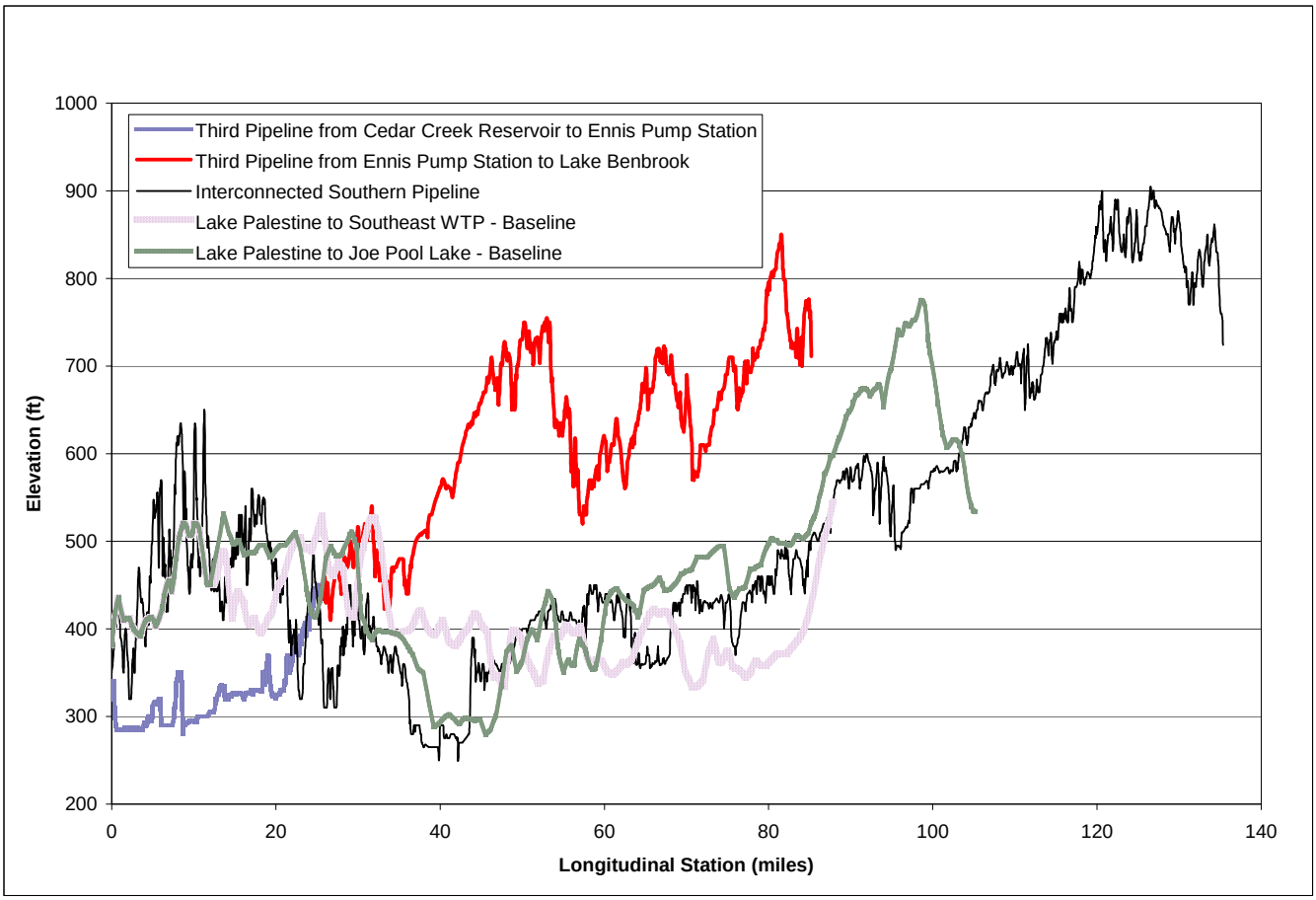


Figure 4-1
Approximate Pipeline Longitudinal Surface Elevation Profiles

4.2 Alternatives Evaluation Matrix

An Alternatives Evaluation Matrix (AEM) was developed to evaluate the occurrence and level of constraints for each pipeline in the project scenarios. This tool is simply a tabulation of the constraints within three classifications, beginning with the generalized "Impact Category", which is then subdivided into "Evaluation Criteria", which are further subdivided into "Components".

1. Impact Categories – Basic Data (not constraints, but necessary to the evaluation), Land Use, Environmental, and Technical (Engineering)

2. Evaluation Criteria – This subset of the impact categories represents the place at which ratings were assigned to the potential impact of constraints on a project alternative. For example, in the environmental impact category, the wetlands criteria may be rated as a High, Medium, Low, or None based on the data analyzed for each component.

3. Components – Each criterion is composed of several components, or attributes data, that become the basis for rating the potential impact. To continue with the previous example, the wetlands criteria components include forested wetlands, non-forested, waters of the U.S., etc.

The impact categories and evaluation criteria selected for the AEM are listed in **Table 4-1**.

To support the constraints analysis process, data were collected from reliable sources and stored in an ArcGIS 9 environment using a common spatial projection. A series of constraint maps were then designed so that the team could visualize potential constraints and their interrelationship. A list of the data and sources used for this analysis is shown in **Table 4-2**.

The final products of the constraints analysis were: 1) a collection of data needed for future phases of engineering, such as conceptual and preliminary design; and 2) a qualitative rating of the potential impact on each evaluation criteria and a consensus evaluation of the overall potential impact of the identified constraints on each project conveyance alternative. Subject matter experts provided an opinion based on the constraints data and rated the evaluation criteria. After each component was quantified and the evaluation criteria were rated, the evaluation team reached consensus on the overall potential impact rating for each scenario.

Table 4-1
Constraint Evaluation Criteria

Impact Category	Category ID No.	Evaluation Criteria
Basic Data	B.1	Intake Facilities; Intake pump station
	B.2	Transmission Facilities Pipelines and Booster PS
Land Use	L.1	Residences
	L.2	Commercial Businesses
	L.3	Schools
	L.4	Parks and Recreation Areas
	L.5	Oil & Gas
	L.6	Other Wells
	L.7	Hazardous Material Sites
	L.8	Airports
	L.9	Mines
	L.10	Existing Roads, Highways and Railroads
	L.11	Agriculture & Non-Tillable Land Based on Soil Type
	L.12	Land Use
Environmental	E.1	Vegetation
	E.2	Conservation
	E.3	Noise
	E.4	Wetlands/Water of the US
	E.5	Wildlife Habitats
	E.6	Cultural Resources
	E.7	Visual
Technical (Engineering)	T.1	Drainage and Hydrologic
	T.2	Electric Transmission Lines
	T.3	Topography
	T.4	Proximity to Infrastructure
	T.5	Site Conditions

Table 4-2
List of Source and Data Used in Constraint Analysis

Source	Base Map Data
National Hydrography Dataset/EPA	Streams
	Waterbodies
Texas Natural Resource Information System	Contours
	USGS Topographic Map Grid
Texas Railroad Commission	Abstracts
US Census Bureau	Cities
	Parks
	Streets
Source	**Constraint Data**
ERCOT	Electrical Transmission
Texas Commission on Environmental Quality	Impaired Streams
	Impaired Water Bodies
	Permitted Industrial Hazardous Waste Sites
	Radioactive Waste Sites
	Superfund Cleanup Sites
	Surface Water Rights
	Wastewater Outfalls
Texas Education Agency	School Districts
	Schools
Texas Historical Commission	Historical Markers
Texas Historical Commission and USGS	Cemeteries
Texas Parks and Wildlife	State Parks
	Threatened and Endangered Species
	Vegetation Type
Texas Railroad Commission	Oil and Gas Pipelines
	Oil and Gas Wells
Texas Water Development Board	Groundwater Wells
United States Department of Agriculture	Soils/Farm Lands
US Census Bureau	Airports
USGS	Land Use
USGS/National Atlas	Agricultural Mine
	Crushed Stone Mines
	Federal Lands
	National Parks
	Sand/Gravel Mines

4.3 Preliminary Findings and Consensus Evaluations

The preliminary findings of the constraints analysis are contained in the Alternatives Evaluation Matrix (AEM), with an analysis of each evaluation criterion and component, and an impact rating for each evaluation criterion. Using the ratings from each impact category and the opinions of the subject matter experts, a consensus evaluation was reached for each project conveyance alternative. The consensus evaluation is summarized in **Table 4-3**, **Table 4-4** and **Table 4-5.**

The evaluation team agreed that, based on the available data, no fatal flaws were detected in this analysis and each of the pipeline corridors are potentially viable and can be recommended for further analysis.

The consensus evaluations in **Table 4-3**, **Table 4-4** and **Table 4-5** also show that, based on the available data, there are no significant differentiators between project alternatives in terms of land use, environmental, or technical (engineering) constraints. Differentiation in terms of lifecycle cost, reliability, operations and maintenance, water quality, and other factors is addressed in other sections of this report. Subsequent phases of project definition and development will provide the quantitative data needed to differentiate the occurrence and significance of constraints within each alternative pipeline corridor

Table 4-3
Baseline Alternatives Constraints Analysis Consensus Evaluations

Impact Category	Category ID No.	Evaluation Criteria	Baseline				
			DWU 2	DWU 1	TRWD		
			Palestine to JP	Palestine to SE WTP	CC to Ennis	RC to Ennis	Ennis to RHWTP
Basic Data	B.1	Intake Facilities; Intake pump station	--	--	--	--	--
	B.2	Transmission Facilities Pipelines and Booster PS	--	--	--	--	--
Land Use	L.1	Residences	Low	Low	Low	Low	Low
	L.2	Commercial Businesses	Low	Low	Low	Low	Low
	L.3	Schools	None	None	None	None	None
	L.4	Parks and Recreation Areas	None	Low	None	None	Low
	L.5	Oil & Gas	Med	Low	Low	Med	High
	L.6	Other Wells	Low	Low	Low	Low	Low
	L.7	Hazardous Material Sites	Low	Low	Low	Low	Low
	L.8	Airports	Low	Low	Low	Low	Low
	L.9	Mines	Low	Low	Low	Low	Low
	L.10	Existing Roads, Highways and Railroads	Med	Med	Low	Med	High
	L.11	Agriculture & Non-Tillable Land Based on Soil Type	Low	Low	Low	Low	Low
	L.12	Land Use	Med	Med	Low	Low	Med
Environ-mental	E.1	Vegetation	Med	Med	Low	Low	Med
	E.2	Conservation	None	None	None	None	None
	E.3	Noise	Low	Low	Low	Low	Low
	E.4	Wetlands/Water of the US	Med	Med	Low	Med	Med
	E.5	Wildlife Habitats	Med	Med	Med	Med	Med
	E.6	Cultural Resources	Med	Med	Low	Low	Med
	E.7	Visual	Low	Low	Low	Low	Low
Technical (Engin-eering)	T.1	Drainage and Hydrologic	Med	Med	Low	Low	Low
	T.2	Electric Transmission Lines	Med	Low	Low	Low	High
	T.3	Topography	Low	Low	Low	Low	Low
	T.4	Proximity to Infrastructure	Low	Low	Low	Low	Low
	T.5	Site Conditions	Med	High	Med	low	Low
Consensus Evaluation of Constraint Level			Med	Med	Low	Low	Med

Table 4-4
Interconnected Third Pipeline Alternative Constraints Analysis Consensus Evaluations

Impact Category	Category ID No.	Evaluation Criteria	Interconnected Third Pipeline			
			Pal to CC	CC to Ennis PS	RC to Ennis	Ennis to RHWTP
Basic Data	B.1	Intake Facilities; Intake pump station	--	--	--	--
	B.2	Transmission Facilities Pipelines and Booster PS	--	--	--	--
Land Use	L.1	Residences	Low	Low	Low	Med
	L.2	Commercial Businesses	Low	Low	Low	Low
	L.3	Schools	None	None	None	None
	L.4	Parks and Recreation Areas	None	None	None	None
	L.5	Oil & Gas	Med	Low	Med	High
	L.6	Other Wells	Low	Low	Low	Low
	L.7	Hazardous Material Sites	Low	Low	Low	Low
	L.8	Airports	Low	Low	Low	Low
	L.9	Mines	Low	Low	Low	Low
	L.10	Existing Roads, Highways and Railroads	Med	Low	Med	High
	L.11	Agriculture & Non-Tillable Land Based on Soil Type	Low	Low	Low	Low
	L.12	Land Use	Low	Low	Low	Med
Environ-mental	E.1	Vegetation	Low	Low	Low	Med
	E.2	Conservation	Low	None	None	None
	E.3	Noise	Low	Low	Low	Low
	E.4	Wetlands/Water of the US	Med	Low	Med	Med
	E.5	Wildlife Habitats	Med	Med	Med	Med
	E.6	Cultural Resources	Low	Low	Low	Med
	E.7	Visual	Low	Low	Low	Low
Technical (Engin-eering)	T.1	Drainage and Hydrologic	Med	Low	Low	Low
	T.2	Electric Transmission Lines	Low	Low	Low	High
	T.3	Topography	Low	Low	Low	Low
	T.4	Proximity to Infrastructure	Low	Low	Low	Low
	T.5	Site Conditions	High	Med	Low	Low
Consensus Evaluation of Constraint Level			Med	Low	Low	Med

Table 4-5
Interconnected Southern Pipeline Alternative Constraints Analysis Consensus Evaluations

Impact Category	Category ID No.	Evaluation Criteria	Interconnected Southern Pipeline			
			Pal to Benbrook	CC to Southern Rte	RC to Southern Rte	So Rte to JP (intcnct)
Basic Data	B.1	Intake Facilities; Intake pump station	--	--	--	--
	B.2	Transmission Facilities Pipelines and Booster PS	--	--	--	--
Land Use	L.1	Residences	Low	Low	Low	Low
	L.2	Commercial Businesses	Low	Low	Low	Low
	L.3	Schools	None	None	None	None
	L.4	Parks and Recreation Areas	None	None	None	None
	L.5	Oil & Gas	High	Low	High	High
	L.6	Other Wells	Low	Low	Low	Low
	L.7	Hazardous Material Sites	Low	Low	Low	Low
	L.8	Airports	Low	Low	Low	Low
	L.9	Mines	Low	Low	Low	Low
	L.10	Existing Roads, Highways and Railroads	High	Med	High	Med
	L.11	Agriculture & Non-Tillable Land Based on Soil Type	Low	Low	Low	Low
	L.12	Land Use	Low	Low	Low	Low
Environ-mental	E.1	Vegetation	Med	Low	Low	Low
	E.2	Conservation	None	None	None	None
	E.3	Noise	Low	Low	Low	Low
	E.4	Wetlands/Water of the US	Med	Low	Low	Med
	E.5	Wildlife Habitats	Med	Med	Med	Low
	E.6	Cultural Resources	Low	Low	Low	Low
	E.7	Visual	Low	Low	Low	Low
Technical (Engin-eering)	T.1	Drainage and Hydrologic	Med	Low	Med	Med
	T.2	Electric Transmission Lines	Med	Med	Med	High
	T.3	Topography	Low	Low	Low	Low
	T.4	Proximity to Infrastructure	Low	Low	Low	Low
	T.5	Site Conditions	Med	Med	Low	Low
Consensus Evaluation of Constraint Level			Med	Low	Med	Med

Section 5
Environmental Water Quality

The purpose of the environmental water quality review was to assess receiving water quality impacts due to the introduction of Lake Palestine water under varying conditions into Lake Benbrook, Cedar Creek Reservoir, Richland-Chambers Reservoir, and Joe Pool Lake. The water quality review included data collection and analysis, mass balance calculations, and a water quality evaluation.

5.1 Data Collection and Analyses

Multiple sources, including the United States Army Corps of Engineers (USACE), TRWD, Trinity River Authority (TRA), Upper Neches River Municipal Water Authority, and the Texas Commission on Environmental Quality (TCEQ), were used to obtain daily historical reservoir storage and water quality data for this study. Reservoir volume data were analyzed for the following time periods in each of these reservoirs:

- Lake Benbrook: January 1980 - December 2007
- Cedar Creek Reservoir: January 1980 - December 2007
- Richland-Chambers Reservoir: January 1989 - December 2007
- Joe Pool Lake: January 1990 - September 2007.

Water quality data were collected and evaluated for each reservoir from January 1997 through December 2006 for alkalinity, dissolved iron, dissolved manganese, hardness, total dissolved solids, total organic carbon, pH, chlorophyll-A, dissolved oxygen, nitrite + nitrate, orthophosphate phosphorus, total phosphorus, secchi depth, and temperature.

Water quality data from TRWD's field-scale wetland system was collected and analyzed from June 2003 through March 2007. Because not all of the water quality parameters analyzed in the study reservoirs were available from TRWD's field-scale wetland system, this evaluation was limited to the following parameters: alkalinity, hardness, nitrite + nitrate, orthophosphate phosphorus, and total phosphorus.

For comparison purposes, the 2006 Region C Water Plan included an assessment of 5 key surface water quality parameters (ammonia nitrogen, nitrate nitrogen, total phosphorus, chlorophyll-a, and total dissolved solids) in its evaluation of water quality impacts for the recommended water management strategies based upon historical median concentrations of the parameters in the source and receiving waters.

5.2 Environmental Water Quality Mass Balance

As part of this water quality assessment, a water quality mass balance was performed to analyze the impact on water quality due to introducing Lake Palestine water into Lake Benbrook, Cedar Creek Reservoir, Richland-Chambers Reservoir, and/or Joe Pool Lake. The water quality parameters evaluated utilizing a mass balance approach include:

- Alkalinity
- Dissolved Iron
- Dissolved Manganese
- Hardness
- Total Dissolved Solids
- Total Organic Carbon
- Chlorophyll-A
- Dissolved Oxygen
- Nitrite + Nitrate
- Orthophosphate Phosphorus
- Total Phosphorus.

The mass balance calculation utilized the historical water quality conditions shown in **Table 5-1** with the introduction of 102 MGD of water from Lake Palestine over a 3 and 6 month period. Lake Palestine water was added to the receiving reservoir as a volume with a specified concentration. The volume of Lake Palestine water was calculated by multiplying 102 MGD by 90 days for the 3 month mass balance and by 180 days for the 6 month mass balance. Lake Palestine water was introduced under various reservoir volume conditions for Lake Benbrook, Cedar Creek Reservoir, Richland- Chambers Reservoir, and Joe Pool Lake. The destination reservoirs were evaluated at reservoir volume conditions equal to the 50th, 75th, and 90th percentile of historical volume and at 50%, 75%, and 90% of the conservation storage capacity. **Table 5-2**, through **Table 5-5** present the results of the calculated water quality concentrations of each parameter after the introduction of Lake Palestine water.

When available, water quality data from the main body of the reservoirs was utilized. Water quality data from TRWD's field-scale wetland system into Alligator Creek was also utilized for this analysis. Average water quality parameter concentrations were calculated for 3 and 6 month time periods from January 1997 through December 2006 for the reservoirs and from June 2003 through March 2007 for the wetland system. The 3 month averages include the months of July through September and the 6 month averages include the months of June through November. For each parameter in the reservoirs, the 3 and 6 month averages were developed by first averaging the concentrations of samples taken at different depths at the same location at the same time. Then, the concentrations for samples taken on the same date in the main pool of the reservoir were averaged to obtain an overall concentration for the reservoir on each sample date. Finally, the concentrations for dates that fell within the 3 and 6 month time period were averaged to acquire one concentration for each time period that would represent the overall average concentration in the main pool of the reservoir. The Alligator Creek data did not have multiple sampling locations, depths, or multiple samples per day; therefore, the wetland system data was simply averaged in 3 and 6 month time periods.

Table 5-1
Average Background Concentrations for Treatability and Nutrient Parameters

	Parameter	Time Period	Benbrook	Cedar Creek	Richland-Chambers	TRWD Wetland	Joe Pool	Palestine
Treatability Parameters	Alkalinity (mg/L)	3 Month	96.67	59.59	86.25	121.26	102.69	37.50
		6 Month	106.81	61.82	90.51	113.02	106.04	37.85
	Dissolved Iron (ug/L)	3 Month	22.78	26.14	33.91	---	67.74	110.00
		6 Month	22.58	78.73	40.53	---	59.02	110.00
	Dissolved Manganese (ug/L)	3 Month	28.17	132.43	35.64	---	103.77	250.00
		6 Month	24.73	82.61	30.62	---	90.48	250.00
	Hardness (mg/L)	3 Month	140.00	50.00	95.00	171.96	149.38	40.00
		6 Month	140.00	50.00	95.00	167.41	153.17	47.67
	Total Dissolved Solids (mg/L)	3 Month	181.47	130.46	153.48	---	318.88	138.60
		6 Month	189.17	131.71	159.36	---	312.55	138.41
	Total Organic Carbon (mg/L)	3 Month	5.18	6.94	5.39	---	4.05	8.63
		6 Month	5.25	6.91	5.41	---	4.76	8.50
	pH	3 Month	7.98	8.20	8.10	---	8.08	7.65
		6 Month	7.96	8.10	8.07	---	8.13	7.55
Nutrient Parameters	Chlorophyll-A (ug/L)	3 Month	31.57	34.07	21.10	---	6.85	42.83
		6 Month	26.63	30.21	20.98	---	6.85	39.39
	Dissolved Oxygen (mg/L)	3 Month	5.62	5.56	4.85	---	6.39	5.26
		6 Month	5.96	6.21	5.48	---	7.22	5.51
	Nitrite + Nitrate (mg/L)	3 Month	0.01	0.03	0.03	0.11	0.06	0.38
		6 Month	0.02	0.07	0.06	0.20	0.08	0.42
	Orthophosphate Phosphorus (mg/L)	3 Month	0.01	0.04	0.02	0.82	0.02	0.06
		6 Month	0.01	0.03	0.01	0.60	0.02	0.06
	Total Phosphorus (mg/L)	3 Month	0.08	0.11	0.08	0.81	0.03	0.08
		6 Month	0.07	0.10	0.08	0.61	0.06	0.10
	Secchi Depth (m)	3 Month	0.73	0.76	0.93	---	1.07	0.82
		6 Month	0.81	0.78	0.88	---	1.03	0.77
	Temperature (^{o}C)	3 Month	26.73	28.63	27.80	---	28.73	28.20
		6 Month	25.35	26.72	26.11	---	26.29	26.04

Table 5-2
Water Quality Concentrations in Lake Benbrook with the Inclusion of 102 MGD of Lake Palestine Water

					Benbrook Historical Volume by Percentile (acre-feet)			Benbrook Volume by Percentage of Conservation Storage (acre-feet)		
					50th	75th	90th	50%	75%	90%
					81,960	86,240	89,402	42,824	64,236	77,083
		Background Concentrations			Benbrook Parameter Concentrations after Blending 102 MGD of Lake Palestine Water					
	Parameter	Time Period	Benbrook	Palestine						
Treatability Parameters	Alkalinity (mg/L)	3 Month	96.67	37.50	81.29	81.86	82.26	72.88	78.36	80.58
		6 Month	106.81	37.85	78.44	79.29	79.88	67.35	74.30	77.41
	Dissolved Iron (ug/L)	3 Month	22.78	110.00	45.46	44.61	44.03	57.85	49.78	46.50
		6 Month	22.58	110.00	58.55	57.47	56.72	72.61	63.79	59.85
	Dissolved Manganese (ug/L)	3 Month	28.17	250.00	85.85	83.70	82.21	117.36	96.83	88.50
		6 Month	24.73	250.00	117.40	114.64	112.70	153.63	130.92	120.77
	Hardness (mg/L)	3 Month	140.00	40.00	114.00	114.97	115.64	99.79	109.05	112.80
		6 Month	140.00	47.67	102.01	103.15	103.94	87.16	96.47	100.64
	Total Dissolved Solids (mg/L)	3 Month	181.47	138.60	170.33	170.74	171.03	164.24	168.20	169.81
		6 Month	189.17	138.41	168.29	168.91	169.35	160.13	165.24	167.53
	Total Organic Carbon (mg/L)	3 Month	5.18	8.63	6.08	6.04	6.02	6.57	6.25	6.12
		6 Month	5.25	8.50	6.59	6.55	6.52	7.11	6.78	6.64
	pH	3 Month	7.98	7.65						
		6 Month	7.96	7.55						
Nutrient Parameters	Chlorophyll-A (ug/L)	3 Month	31.57	42.83	34.50	34.39	34.31	36.10	35.05	34.63
		6 Month	26.63	39.39	31.88	31.72	31.61	33.93	32.64	32.07
	Dissolved Oxygen (mg/L)	3 Month	5.62	5.26	5.53	5.53	5.54	5.48	5.51	5.53
		6 Month	5.96	5.51	5.78	5.78	5.78	5.70	5.75	5.77
	Nitrite + Nitrate (mg/L)	3 Month	0.01	0.38	0.11	0.11	0.10	0.16	0.13	0.11
		6 Month	0.02	0.42	0.19	0.18	0.18	0.25	0.21	0.19
	Orthophosphate Phosphorus (mg/L)	3 Month	0.01	0.06	0.02	0.02	0.02	0.03	0.02	0.02
		6 Month	0.01	0.06	0.03	0.03	0.03	0.04	0.03	0.03
	Total Phosphorus (mg/L)	3 Month	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
		6 Month	0.07	0.10	0.08	0.08	0.08	0.09	0.09	0.09
	Secchi Depth (m)	3 Month	0.73	0.82						
		6 Month	0.81	0.77						
	Temperature (°C)	3 Month	26.73	28.20						
		6 Month	25.35	26.04						

Table 5-3
Water Quality Concentrations in Cedar Creek Reservoir with the Inclusion of 102 MGD of Lake Palestine Water

					Cedar Creek Historical Volume by Percentile (acre-feet)			Cedar Creek Volume by Percentage of Conservation Storage (acre-feet)		
					50th	75th	90th	50%	75%	90%
					619,743	636,241	639,596	322,393	483,589	580,307
	Parameter	Background Concentrations			Cedar Creek Parameter Concentrations after Blending 102 MGD of Lake Palestine Water					
		Time Period	Cedar Creek	Palestine						
Treatability Parameters	Alkalinity (mg/L)	3 Month	59.59	37.50	58.60	58.63	58.63	57.77	58.34	58.54
		6 Month	61.82	37.85	59.80	59.84	59.85	58.21	59.29	59.67
	Dissolved Iron (ug/L)	3 Month	26.14	110.00	29.87	29.77	29.76	33.02	30.86	30.11
		6 Month	78.73	110.00	81.37	81.31	81.30	83.45	82.04	81.54
	Dissolved Manganese (ug/L)	3 Month	132.43	250.00	137.65	137.52	137.50	142.07	139.04	137.99
		6 Month	82.61	250.00	96.77	96.44	96.37	107.86	100.34	97.65
	Hardness (mg/L)	3 Month	50.00	40.00	49.56	49.57	49.57	49.18	49.44	49.53
		6 Month	50.00	47.67	49.80	49.81	49.81	49.65	49.75	49.79
	Total Dissolved Solids (mg/L)	3 Month	130.46	138.60	130.82	130.81	130.81	131.13	130.92	130.85
		6 Month	131.71	138.41	132.28	132.26	132.26	132.72	132.42	132.31
	Total Organic Carbon (mg/L)	3 Month	6.94	8.63	7.02	7.01	7.01	7.08	7.04	7.02
		6 Month	6.91	8.50	7.05	7.04	7.04	7.15	7.08	7.05
	pH	3 Month	8.20	7.65						
		6 Month	8.10	7.55						
Nutrient Parameters	Chlorophyll-A (ug/L)	3 Month	34.07	42.83	34.46	34.45	34.45	34.79	34.56	34.48
		6 Month	30.21	39.39	30.98	30.97	30.96	31.59	31.18	31.03
	Dissolved Oxygen (mg/L)	3 Month	5.56	5.26	5.55	5.55	5.55	5.54	5.55	5.55
		6 Month	6.21	5.51	6.15	6.15	6.15	6.11	6.14	6.15
	Nitrite + Nitrate (mg/L)	3 Month	0.03	0.38	0.05	0.05	0.05	0.06	0.05	0.05
		6 Month	0.07	0.42	0.10	0.10	0.10	0.12	0.11	0.10
	Orthophosphate Phosphorus (mg/L)	3 Month	0.04	0.06	0.04	0.04	0.04	0.04	0.04	0.04
		6 Month	0.03	0.06	0.04	0.04	0.04	0.04	0.04	0.04
	Total Phosphorus (mg/L)	3 Month	0.11	0.08	0.11	0.11	0.11	0.11	0.11	0.11
		6 Month	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
	Secchi Depth (m)	3 Month	0.76	0.82						
		6 Month	0.78	0.77						
	Temperature (°C)	3 Month	28.63	28.20						
		6 Month	26.72	26.04						

Table 5-4
Water Quality Concentrations in Richland-Chambers Reservoir with the Inclusion of 102 MGD of Lake Palestine Water

					Richland-Chambers Historical Volume by Percentile (acre-feet)			Richland-Chambers Volume by Percentage of Conservation Storage (acre-feet)		
					50th	75th	90th	50%	75%	90%
					1,110,070	1,138,876	1,154,625	568,300	852,450	1,022,940
	Parameter	Background Concentrations			Richland-Chambers Parameter Concentrations after Blending 102 MGD of Lake Palestine Water					
		Time Period	Richland - Chambers	Palestine						
Treatability Parameters	Alkalinity (mg/L)	3 Month	86.25	37.50	85.02	85.05	85.07	83.90	84.66	84.92
		6 Month	90.51	37.85	87.92	87.99	88.02	85.69	87.19	87.71
	Dissolved Iron (ug/L)	3 Month	33.91	110.00	35.84	35.79	35.76	37.58	36.40	36.00
		6 Month	40.53	110.00	43.94	43.85	43.81	46.89	44.90	44.21
	Dissolved Manganese (ug/L)	3 Month	35.64	250.00	41.06	40.93	40.86	45.98	42.65	41.51
		6 Month	30.62	250.00	41.38	41.12	40.99	50.71	44.43	42.25
	Hardness (mg/L)	3 Month	95.00	40.00	93.61	93.64	93.66	92.35	93.20	93.49
		6 Month	95.00	47.67	92.68	92.73	92.76	90.67	92.02	92.49
	Total Dissolved Solids (mg/L)	3 Month	153.48	138.60	153.11	153.12	153.12	152.77	153.00	153.08
		6 Month	159.36	138.41	158.33	158.36	158.37	157.44	158.04	158.25
	Total Organic Carbon (mg/L)	3 Month	5.39	8.63	5.48	5.47	5.47	5.55	5.50	5.48
		6 Month	5.41	8.50	5.57	5.56	5.56	5.70	5.61	5.58
	pH	3 Month	8.10	7.65						
		6 Month	8.07	7.55						
Nutrient Parameters	Chlorophyll-A (ug/L)	3 Month	21.10	42.83	21.65	21.64	21.63	22.15	21.81	21.69
		6 Month	20.98	39.39	21.89	21.86	21.85	22.67	22.14	21.96
	Dissolved Oxygen (mg/L)	3 Month	4.85	5.26	4.86	4.86	4.86	4.87	4.86	4.86
		6 Month	5.48	5.51	5.48	5.48	5.48	5.48	5.48	5.48
	Nitrite + Nitrate (mg/L)	3 Month	0.03	0.38	0.03	0.03	0.03	0.04	0.04	0.04
		6 Month	0.06	0.42	0.07	0.07	0.07	0.09	0.08	0.08
	Orthophosphate Phosphorus (mg/L)	3 Month	0.02	0.06	0.02	0.02	0.02	0.02	0.02	0.02
		6 Month	0.01	0.06	0.02	0.02	0.02	0.02	0.02	0.02
	Total Phosphorus (mg/L)	3 Month	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
		6 Month	0.08	0.10	0.08	0.08	0.08	0.08	0.08	0.08
	Secchi Depth (m)	3 Month	0.93	0.82						
		6 Month	0.88	0.77						
	Temperature (°C)	3 Month	27.80	28.20						
		6 Month	26.11	26.04						

Table 5-5
Water Quality Concentrations in Joe Pool Lake with the Inclusion of 102 MGD of Lake Palestine Water

					Joe Pool Historical Volume by Percentile (acre-feet)			Joe Pool Volume by Percentage of Conservation Storage (acre-feet)		
					50th	75th	90th	50%	75%	90%
					176,074	178,844	184,316	88,448	132,671	159,206
		Background Concentrations			Joe Pool Parameter Concentrations after Blending 102 MGD of Lake Palestine Water					
	Parameter	Time Period	Joe Pool	Palestine						
Treatability Parameters	Alkalinity (mg/L)	3 Month	102.69	37.50	93.53	93.65	93.88	86.68	91.07	92.71
		6 Month	106.04	37.85	89.30	89.50	89.87	79.24	85.48	88.00
	Dissolved Iron (ug/L)	3 Month	67.74	110.00	73.68	73.60	73.45	78.12	75.28	74.22
		6 Month	59.02	110.00	71.54	71.39	71.11	79.06	74.40	72.51
	Dissolved Manganese (ug/L)	3 Month	103.77	250.00	124.32	124.05	123.53	139.68	129.85	126.17
		6 Month	90.48	250.00	129.64	129.18	128.30	153.18	138.59	132.69
	Hardness (mg/L)	3 Month	149.38	40.00	134.00	134.21	134.60	122.51	129.87	132.62
		6 Month	153.17	47.67	127.27	127.57	128.15	111.70	121.35	125.25
	Total Dissolved Solids (mg/L)	3 Month	318.88	138.60	293.54	293.87	294.52	274.60	286.72	291.26
		6 Month	312.55	138.41	269.80	270.30	271.26	244.10	260.04	266.47
	Total Organic Carbon (mg/L)	3 Month	4.05	8.63	4.69	4.69	4.67	5.18	4.87	4.75
		6 Month	4.76	8.50	5.68	5.67	5.65	6.23	5.89	5.75
	pH	3 Month	8.08	7.65						
		6 Month	8.13	7.55						
Nutrient Parameters	Chlorophyll-A (ug/L)	3 Month	6.85	42.83	11.91	11.84	11.71	15.69	13.27	12.36
		6 Month	6.85	39.39	14.84	14.75	14.57	19.64	16.66	15.46
	Dissolved Oxygen (mg/L)	3 Month	6.39	5.26	6.23	6.23	6.23	6.11	6.19	6.21
		6 Month	7.22	5.51	6.80	6.80	6.81	6.55	6.70	6.77
	Nitrite + Nitrate (mg/L)	3 Month	0.06	0.38	0.10	0.10	0.10	0.14	0.12	0.11
		6 Month	0.08	0.42	0.16	0.16	0.16	0.21	0.18	0.17
	Orthophosphate Phosphorus (mg/L)	3 Month	0.02	0.06	0.02	0.02	0.02	0.03	0.02	0.02
		6 Month	0.02	0.06	0.03	0.03	0.03	0.03	0.03	0.03
	Total Phosphorus (mg/L)	3 Month	0.03	0.08	0.04	0.04	0.04	0.04	0.04	0.04
		6 Month	0.06	0.10	0.07	0.07	0.07	0.08	0.07	0.07
	Secchi Depth (m)	3 Month	1.07	0.82						
		6 Month	1.03	0.77						
	Temperature (°C)	3 Month	28.73	28.20						

Because water quality data were not available for the field-scale wetland system for all of the parameters included in this analysis, **Table 5-3** and **Table 5-4** do not include the addition of the future Cedar Creek and Richland-Chambers constructed wetland systems. A separate analysis of only the parameters available in the wetlands data was performed to show the addition of the wetland systems and the results are shown in **Table 5-6** and **Table 5-7**. Under CA 08-4976C, TRWD may divert 88,059 ac-ft/yr at a maximum rate of 156.6 cfs from the Cedar Creek wetland system to Cedar Creek Reservoir. Under CA 08-5035C, TRWD may divert 100,465 ac-ft/yr or a maximum of 11,398 ac-ft/month from the Richland-Chambers wetland system to Richland - Chambers Reservoir. The impact of including the Richland-Chambers and Cedar Creek wetland systems was evaluated at their maximum monthly diversion rate over a 3 and 6 month time period.

Table 5-6
Water Quality Concentrations in Cedar Creek Reservoir with Wetland Effluent and the Inclusion of 102 MGD of Lake Palestine Water

						Cedar Creek Historical Volume by Percentile (acre-feet)			Cedar Creek Volume by Percentage of Conservation Storage (acre-feet)		
						50th	75th	90th	50%	75%	90%
						619,743	636,241	639,596	322,393	483,589	580,307
	Parameter	Background Concentrations Time Period	Cedar Creek	Wetland	Palestine	Cedar Creek Parameter Concentrations after Blending Wetland Effluent and 102 MGD of Lake Palestine Water					
Treatability Parameters	Alkalinity (mg/L)	3 Month	59.59	121.26	37.50	61.25	61.21	61.20	62.55	61.67	61.35
		6 Month	61.82	113.02	37.85	63.92	63.87	63.86	65.35	64.40	64.04
	Dissolved Iron (ug/L)	3 Month	26.14	---	110.00						
		6 Month	78.73	---	110.00						
	Dissolved Manganese (ug/L)	3 Month	132.43	---	250.00						
		6 Month	82.61	---	250.00						
	Hardness (mg/L)	3 Month	50.00	171.96	40.00	54.72	54.61	54.59	58.42	55.91	55.01
		6 Month	50.00	167.41	47.67	58.91	58.72	58.68	64.98	60.94	59.42
	Total Dissolved Solids (mg/L)	3 Month	130.46	---	138.60						
		6 Month	131.71	---	138.41						
	Total Organic Carbon (mg/L)	3 Month	6.94	---	8.63						
		6 Month	6.91	---	8.50						
	pH	3 Month	8.20	---	7.65						
		6 Month	8.10	---	7.55						
Nutrient Parameters	Chlorophyll-A (ug/L)	3 Month	34.07	---	42.83						
		6 Month	30.21	---	39.39						
	Dissolved Oxygen (mg/L)	3 Month	5.56	---	5.26						
		6 Month	6.21	---	5.51						
	Nitrite + Nitrate (mg/L)	3 Month	0.03	0.11	0.38	0.05	0.05	0.05	0.06	0.05	0.05
		6 Month	0.07	0.20	0.42	0.11	0.11	0.11	0.13	0.12	0.11
	Orthophosphate Phosphorus (mg/L)	3 Month	0.04	0.82	0.06	0.08	0.08	0.08	0.10	0.08	0.08
		6 Month	0.03	0.60	0.06	0.08	0.08	0.08	0.11	0.09	0.08
	Total Phosphorus (mg/L)	3 Month	0.11	0.81	0.08	0.14	0.14	0.14	0.16	0.15	0.14
		6 Month	0.10	0.61	0.10	0.14	0.14	0.14	0.17	0.15	0.15
	Secchi Depth (m)	3 Month	0.76	---	0.82						
		6 Month	0.78	---	0.77						
	Temperature (°C)	3 Month	28.63	---	28.20						
		6 Month	26.72	---	26.04						

Table 5-7
Water Quality Concentrations in Richland-Chambers Reservoir with Wetland Effluent and the Inclusion of 102 MGD of Lake Palestine Water

						Richland-Chambers Volume by Percentile (acre-feet)			Richland-Chambers Volume by Percentage of Conservation Storage (acre-feet)		
						50th	75th	90th	50%	75%	90%
						1,110,070	1,138,876	1,154,625	568,300	852,450	1,022,940
		Background Concentrations				Richland-Chambers Parameter Concentrations after Blending Wetland Effluent and 102 MGD of Lake Palestine Water					
	Parameter	Time Period	Richland-Chambers	Wetland	Palestine						
Treatability Parameters	Alkalinity (mg/L)	3 Month	86.25	121.26	37.50	86.08	86.08	86.08	85.92	86.03	86.06
		6 Month	90.51	113.02	37.85	89.31	89.34	89.35	88.38	89.00	89.22
	Dissolved Iron (ug/L)	3 Month	33.91	---	110.00						
		6 Month	40.53	---	110.00						
	Dissolved Manganese (ug/L)	3 Month	35.64	---	250.00						
		6 Month	30.62	---	250.00						
	Hardness (mg/L)	3 Month	95.00	171.96	40.00	95.89	95.87	95.86	96.66	96.14	95.96
		6 Month	95.00	167.41	47.67	96.81	96.77	96.75	98.23	97.29	96.95
	Total Dissolved Solids (mg/L)	3 Month	153.48	---	138.60						
		6 Month	159.36	---	138.41						
	Total Organic Carbon (mg/L)	3 Month	5.39	---	8.63						
		6 Month	5.41	---	8.50						
	pH	3 Month	8.10	---	7.65						
		6 Month	8.07	---	7.55						
Nutrient Parameters	Chlorophyll-A (ug/L)	3 Month	21.10	---	42.83						
		6 Month	20.98	---	39.39						
	Dissolved Oxygen (mg/L)	3 Month	4.85	---	5.26						
		6 Month	5.48	---	5.51						
	Nitrite + Nitrate (mg/L)	3 Month	0.03	0.11	0.38	0.04	0.04	0.04	0.05	0.04	0.04
		6 Month	0.06	0.20	0.42	0.08	0.08	0.08	0.10	0.09	0.08
	Orthophosphate Phosphorus (mg/L)	3 Month	0.02	0.82	0.06	0.04	0.04	0.04	0.06	0.05	0.04
		6 Month	0.01	0.60	0.06	0.05	0.05	0.05	0.08	0.06	0.05
	Total Phosphorus (mg/L)	3 Month	0.08	0.81	0.08	0.11	0.10	0.10	0.12	0.11	0.11
		6 Month	0.08	0.61	0.10	0.11	0.11	0.11	0.13	0.12	0.11
Secchi Depth (m)		3 Month	0.93	---	0.82						
		6 Month	0.88	---	0.77						
Temperature (°C)		3 Month	27.80	---	28.20						
		6 Month	26.11	---	26.04						

5.3 Environmental Water Quality Evaluation Results

The impact on each receiving reservoir was evaluated under volume conditions equal to the 50th, 75th, and 90th percentile of historical volume and at 50%, 75%, and 90% of the conservation storage capacity. The historical water quality concentrations and calculated concentrations from the mass balance for the reservoirs and the wetland system were evaluated and the results are presented below.

As noted in the 2006 Region C Water Plan, in general, East Texas reservoirs such as Lake Palestine have higher concentrations of nutrients than the evaluated receiving reservoirs discussed below. The Region C Water Plan notes that all of the water management strategies involving importation of water from East Texas were considered to have "low" or "medium-low" impacts on key water quality parameters.

5.3.1 Lake Benbrook

Although not considered to be a highly probable operational scenario, directly blending 102 MGD of Lake Palestine water with Lake Benbrook would have the following impacts:

- An increase to dissolved iron, dissolved manganese, nitrite + nitrate, and orthophosphate phosphorus concentrations in Lake Benbrook;
- Lesser impact to alkalinity, total organic carbon, chlorophyll-A, and total phosphorus; and
- Improvement to hardness and total dissolved solids concentrations with the addition of Lake Palestine water.

5.3.2 Cedar Creek Reservoir

Blending 102 MGD of Lake Palestine water with Cedar Creek Reservoir would have the following impacts:

- An increase to the nitrite + nitrate concentration in Cedar Creek Reservoir;
- Lesser impact to alkalinity, dissolved iron, dissolved manganese, chlorophyll-A, and orthophosphate phosphorus; and
- Negligible impacts, both positive and negative, to hardness, total dissolved solids, total organic carbon, and total phosphorus.

With the inclusion of the wetland system and the blending of Lake Palestine water: nitrite + nitrate, orthophosphate phosphorus would increase from the historical concentration levels. Hardness would also increase from the historical concentration but to a lesser degree. Alkalinity will improve with the inclusion of the wetland system and the blending of Lake Palestine water.

5.3.3 Richland-Chambers Reservoir

Blending 102 MGD of Lake Palestine water with Richland-Chambers Reservoir would have the following impacts:

- An increase to the dissolved manganese and nitrite + nitrate concentration in Richland-Chambers Reservoir;
- Lesser negative impact to alkalinity, dissolved iron, total organic carbon, chlorophyll-A, and orthophosphate phosphorus;
- Improvement to the hardness in Richland-Chambers Reservoir with the addition of Lake Palestine water; and
- Negligible impacts, both positive and negative, to total dissolved solids and total phosphorus.

With the inclusion of the wetland system and the blending of Lake Palestine water nitrite + nitrate, orthophosphate phosphorus, and the total phosphorus would increase from the historical concentration. The negative impact to alkalinity and hardness from the historical concentration would be negligible with the inclusion of the wetland system and the blending of Lake Palestine water.

5.3.4 Joe Pool Lake

Blending 102 MGD of Lake Palestine water with Joe Pool Lake would:

- Increase dissolved manganese, chlorophyll-A, nitrite + nitrate, and orthophosphate phosphorus concentrations in Joe Pool Lake
- Negatively impact, though to a lesser extent, alkalinity, dissolved iron, total organic carbon, and total phosphorus; and
- Improve hardness and total dissolved solids concentrations with the addition of Lake Palestine water.

Section 6
Water Treatment Considerations

Blending TRWD and DWU raw water supplies would impact raw water quality and potentially the treatment requirements at water treatment plants that receive raw water from these entities. The purpose of this raw water treatment review and treatability analysis was to consider several potential scenarios of blending and transmission that would cause water quality changes that may require modifications to the existing water treatment plant processes.

The four project conveyance alternatives, described in **Table 1-1**, are reproduced below for the reader's convenience.

Alternative	Description
1 (Baseline)	Independent Systems: TRWD's East Texas Third Pipeline and DWU's connection of Lake Palestine to the proposed Southeast Water Treatment Plant
2 (Baseline)	Independent Systems: TRWD's East Texas Third Pipeline and DWU's connection of Lake Palestine to Joe Pool Lake
3 (Interconnection)	Integrated System: Interconnected Third Pipeline (upsized as compared to the baseline condition) with connection of Lake Palestine to Cedar Creek Reservoir and delivery to DWU at Joe Pool Lake and TRWD's customers through the Third Pipeline
4 (Interconnection)	Integrated System: Interconnected "Southern Pipeline" - Lake Palestine delivered to the Lake Benbrook area via a pipeline route to the south of the TRWD Third Pipeline route. Delivery to DWU at Joe Pool Lake and TRWD's customers through connections to the existing system and the Lake Benbrook pipeline.

In the two Baseline alternatives, TRWD would continue to provide raw water to its customer treatment facilities and DWU would deliver raw water to either the proposed Southeast Water Treatment Plant or to the Joe Pool Lake vicinity, for treatment nearby at a new water treatment plant or at the Dallas Bachman WTP. This is also the case for the two Interconnection alternatives with the exception that it was assumed DWU would deliver raw water only to the Joe Pool Lake area for treatment nearby at a new facility or at the Dallas Bachman WTP.

Due to the unlimited possible combinations of source water blends, this treatment evaluation confined the assumed blends to Lake Palestine water discharged solely into one of the four reservoirs: Richland-Chambers, Cedar Creek, Joe Pool or Benbrook. It was further assumed that water supplied from Richland-Chambers Reservoir and Cedar Creek Reservoir would be blended at a 2:1 ratio, similar to typical existing operations.

6.1 Water Quality Parameters of Concern

Raw water quality parameters that could impact treatment processes primarily include alkalinity, hardness, total organic carbon (TOC), total dissolved solids (TDS), bromide, iron, and manganese. The potential impacts of each of these parameters are discussed below.

Alkalinity. Alkalinity is a measure of water's ability to neutralize acid - its buffering capability. Waters with low alkalinity are typically more difficult to treat. Lower alkalinity waters will also require additional TOC reduction per the EPA Stage 1 Disinfectants/Disinfection Byproduct Rule (D/DBPR). Low alkalinity waters would also impact the design of, and materials used in, the transmission systems.

Hardness. Waters with high levels of hardness may require implementation of a softening process at the treatment plant. Such processes are more costly to construct and operate than conventional plants. For example, lime softening process produces significantly greater amounts of sludge that must be handled. Hardness levels are not a concern for any of the TRWD or DWU raw water supplies and were therefore assumed to not be an issue in this evaluation.

Total Organic Carbon. TOC levels have a direct impact on disinfection byproduct (DBP) formation. Raw water with a higher concentration of TOC will result in greater formation of regulated DBPs. Although TOC is not specifically regulated, a certain percentage of TOC reduction is required by the D/DBPR, and higher levels of raw water TOC require higher rates of TOC reduction.

Total Dissolved Solids. TDS is a measure of the concentration of minerals in the water. The Federal Secondary Standard for TDS is 500 mg/L and the TCEQ Secondary Standard is 1000 mg/L. Raw water supplies with TDS levels higher than the secondary standards would require higher-level treatment processes, such as reverse osmosis. TDS levels are not a problem for any of the TRWD or DWU raw water supplies and were not considered in this evaluation.

Bromide. Although Bromide is not a regulated parameter, its presence in raw water, can trigger a reaction with ozone to form bromate, a regulated compound. If the bromate concentration exceeds 10 ug/L, control techniques must be implemented, applied ozone dose reduced, or the ozonation process removed. Most of the WTPs that would be impacted by the interconnection of the raw water transmission system use ozonation as part of the treatment process.

Iron and Manganese. Iron and manganese are metals primarily associated with aesthetic water quality concerns, such as metallic tastes and staining of plumbing fixtures and laundry. Iron and manganese are regulated as secondary standards, with maximum levels of 0.3 mg/L and 0.05 mg/L respectively. Waters with higher levels of iron and manganese require removal, typically oxidation by aeration or with chlorine dioxide or permanganate. Ozone will also oxidize iron and manganese, but would typically not be added specifically for this purpose.

6.2 Reservoir Water Quality

Water quality parameters for the various reservoirs are summarized in Section 5. For purposes of this treatability analysis, the six month average water quality data between June and November were used. The reservoir water quality data are summarized below in **Table 6-1**.

Table 6-1
Reservoir Water Quality

Water Quality Parameter	Lake Palestine	Cedar Creek Reservoir	Richland-Chambers Reservoir	Lake Benbrook	Joe Pool Lake	Elm Fork Trinity River
Alkalinity (mg/L)	38	62	91	107	106	110
Hardness (mg/L)	48	50	95	140	153	140
TOC (mg/L)	8.5	6.9	5.4	5.3	4.8	5.0
TDS (mg/L)	138	132	159	189	313	N/A
Bromide (mg/L)	0.12	0.09	0.09	0.12	N/A	0.13
Iron (ug/L)	110	79	41	23	59	<100
Manganese (ug/L)	250	83	31	25	90	N/A

The Baseline and Interconnected water supply alternatives would result in changes to water quality that differ from the current raw water supplies provided to the TRWD customer water treatment plants and the DWU Bachman water treatment plant. This analysis used the blended water quality data presented in the Espey Consultants May, 2008 technical memorandum and used the **50th percentile reservoir volume** scenarios. A summary of water quality for each alternative is presented below.

6.3 DWU Water Treatment Considerations, Baseline Alternatives 1 and 2

The Baseline alternatives include taking raw water either directly from Lake Palestine to a new Southeast Water Treatment Plant (SEWTP) (Alternative 1), or taking Lake Palestine water to Joe Pool Lake for treatment at a new treatment plant nearby or at the Bachman WTP (Alternative 2). Therefore, in Baseline Alternative 1 water quality at the proposed SEWTP would be the same as Lake Palestine water quality. In Baseline Alternative 2, it was assumed that water would be taken from the pipeline prior to discharging into Joe Pool Lake. Therefore, water quality at a new treatment plant at Joe Pool Lake, or at the Bachman WTP, would be the same as Lake Palestine water.

Table 6-2 presents calculated water quality delivered to Dallas water treatment plants for these two Baseline alternatives and, for comparative purposes, the current raw water quality at the Bachman WTP.

Table 6-2
Water Quality with Implementation of DWU Baseline Alternative

Water Quality Parameter	SEWTP, New WTP near Joe Pool Lake, and Bachman WTP from Lake Palestine	Lake Palestine/Joe Pool Lake Blend (1)	Current Bachman Raw From Trinity River
Alkalinity (mg/L)	38	89	110
Hardness (mg/L)	48	127	140
TOC (mg/L)	8.5	5.7	5.0
TDS (mg/L)	138	270	
Bromide (mg/L)	0.12	–	0.13
Iron (ug/L)	110	72	<100
Manganese (ug/L)	250	130	

Note (1): The water quality blend illustrated in this column would only be applicable to a new water treatment plant near Joe Pool Lake or the Bachman WTP if a blend of Lake Palestine and Joe Pool Lake waters were used.

6.4 TRWD Water Treatment Considerations, Baseline Alternatives 1 and 2

For TRWD, Baseline Alternatives 1 and 2 include adding a Third Pipeline to carry raw water from Cedar Creek and Richland-Chambers Reservoirs (including water supply augmentation from the constructed wetlands) to its customers. TRWD would continue to use Lake Benbrook as terminal storage, primarily for the Fort Worth Rolling Hills WTP and future Westside WTP. Under the baseline alternatives, TRWD customers would not see a significant change in the water treatment parameters. **Table 6-3** presents potential water quality blends delivered to TRWD customer water treatment plants for the Baseline Alternatives 1 and 2. The Richland-Chambers/Cedar Creek blend was assumed to be a 2:1 blend ratio.

Table 6-3
Water Quality with Implementation of TRWD Baseline Alternative

Water Quality Parameter	Cedar Creek Reservoir	Richland-Chambers Reservoir	Cedar Creek/ Richland-Chambers Blend	Lake Benbrook
Alkalinity (mg/L)	62	91	81	107
Hardness (mg/L)	50	95	80	140
TOC (mg/L)	6.9	5.4	5.9	5.3
TDS (mg/L)	132	159	154	189
Bromide (mg/L)	0.09	0.09	0.09	0.12
Iron (ug/L)	79	41	54	23
Manganese (ug/L)	83	31	48	25

6.5 Interconnection Alternative 3 Water Treatment Considerations – Lake Palestine to Cedar Creek Reservoir

Under this Interconnection alternative, Lake Palestine water would be pumped to Cedar Creek Reservoir. The Lake Palestine/Cedar Creek blend may then be combined with Richland-Chambers water in the transmission system before delivery to TRWD customers and before delivery to DWU at Joe Pool Lake (for treatment nearby at a new WTP or at Bachman WTP). For this analysis, the raw water was assumed to be a 2:1 blend of water originating from Richland-Chambers Reservoir and Cedar Creek Reservoir (including Lake Palestine). **Table 6-4** presents potential water quality delivered through the interconnected system for this alternative.

Table 6-4
Water Quality with Delivery of Lake Palestine to Cedar Creek

Water Quality Parameter	Lake Palestine	Cedar Creek Reservoir	Lake Palestine/ Cedar Creek Blend	Richland-Chambers Reservoir	Cedar Creek/ Richland-Chambers Blend
Alkalinity (mg/L)	38	62	60	91	81
Hardness (mg/L)	48	50	50	95	80
TOC (mg/L)	8.5	6.9	7.0	5.4	5.9
TDS (mg/L)	138	132	132	159	150
Bromide (mg/L)	0.12	0.09	–	0.09	–
Iron (ug/L)	110	79	81	41	54
Manganese (ug/L)	250	83	97	31	53

6.6 Interconnection Alternative 4 Water Treatment Considerations – Lake Palestine to Lake Benbrook

Under this Interconnection alternative (the "southern pipeline"), Lake Palestine water could be pumped directly to the Lake Benbrook area bypassing Richland-Chambers and Cedar Creek during certain system operations. The Lake Palestine water could then be supplied to the Fort Worth Rolling Hills WTP and Westside WTP. Prior to reaching the Lake Benbrook area, Lake Palestine water could also supply the future Fort Worth Southwest WTP. All three of these plants could also be supplied from Cedar Creek Reservoir and Richland-Chambers Reservoir which would include blends of Lake Palestine and constructed wetlands waters. Other TRWD customers would continue to receive water directly from Richland-Chambers and Cedar Creek Reservoirs through the existing TRWD transmission pipelines.

Lake Palestine water from the southern pipeline would also be provided to the Joe Pool Lake area to supply the Bachman WTP or other new treatment facilities. The potential delivery of Lake Palestine water directly to the Lake Benbrook area is considered to be an infrequent possibility since it assumes the direct transfer of unblended Lake Palestine water to the outermost edge of the study area. Nevertheless, it provides the most extreme blending scenario in terms of water treatment considerations for an integrated system for some of the TRWD customers.

Table 6-5 presents potential water quality delivered through Interconnection Alternative 4 for this blending scenario. It also shows the water quality if Lake Palestine water were blended with Lake Benbrook water. Due to permitting and contract issues, this is not considered a likely scenario in the foreseeable future.

Table 6-5
Water Quality with Delivery of Lake Palestine to the Lake Benbrook Area

Water Quality Parameter	Fort Worth WTPs from Lake Palestine	Lake Benbrook	Lake Palestine/ Lake Benbrook Blend (1)
Alkalinity (mg/L)	38	107	78
Hardness (mg/L)	48	140	102
TOC (mg/L)	8.5	5.3	6.6
TDS (mg/L)	138	189	168
Bromide (mg/L)	0.12	0.12	–
Iron (ug/L)	110	23	59
Manganese (ug/L)	250	25	117

Note (1): For informational purposes. Not a likely scenario.

6.7 Treatability Issues

The Baseline and Integrated water supply alternatives present changes in raw water quality that will impact the treatment processes at the water treatment plants and could increase operational costs and potentially require additional capital expenditures. A discussion of the treatability issues for each project conveyance alternative follows.

6.7.1 Baseline Alternatives

Under Baseline Alternatives 1 and 2, WTPs currently receiving raw water from TRWD would continue to receive water delivered from Richland-Chambers Reservoir and Cedar Creek Reservoir, both of which would also include constructed wetlands augmentation in the future. The Fort Worth Rolling Hills WTP and future Westside WTP would also continue to receive water from Lake Benbrook under seasonal operational scenarios. No impact to water quality or treatability related to Lake Palestine would occur under this scenario.

Under Baseline Alternatives 1 and 2, either the proposed DWU Southeast WTP, new WTP near Joe Pool Lake, or the Bachman WTP would receive raw water directly from Lake Palestine. This water quality would be significantly different from the Elm Fork of the Trinity River raw water currently supplied to the Bachman WTP. The DWU WTPs could expect the following water quality and treatability issues under Alternatives 1 and 2:

- The raw water alkalinity would be less than 60 mg/L, limiting the raw water's buffering capability and making it more difficult to treat. The TOC would be above 8.0 mg/L, meaning that 50% of the TOC must be removed during the treatment process or an alternative minimum TOC removal requirement must be implemented. The proposed SEWTP could expect to use greater amounts of coagulant than those currently used at the Bachman WTP. Bench scale studies would be required to determine the actual amounts of coagulant required.

- The high levels of TOC raise the potential for high levels of disinfection byproduct (DBP) formation. If ozonation were to be used as the primary disinfectant (as at the Bachman WTP) and chloramine as the residual disinfectant, the plant should be able to control DBPs successfully.

- Iron levels from Lake Palestine water are somewhat elevated, but fall within the regulatory secondary standards. Plants utilizing ozone or chlorine dioxide would oxidize some of the iron, thereby reducing the iron content in the finished water.

- Manganese levels from Lake Palestine are well above the regulatory secondary drinking water standards. These manganese levels could be reduced to below the regulatory standards through oxidation with ozone, if it were applied similar to methods used at the Bachman WTP. However, care would be required to limit the potential for conversion of the manganese to permanganate, which could result in pink water. The use of biological filtration following the ozonation process has shown to be effective for manganese reduction. It is anticipated that approximately 0.25 mg/L of additional ozone dose would be required to provide the desired manganese oxidation. This would be in addition to the dosage required for disinfection and taste and odor control.

If under Baseline Alternative 2 the Lake Palestine water were pumped directly into Joe Pool Lake and then delivered to a new WTP near Joe Pool Lake or the Bachman WTP, the water quality parameters would be similar to current raw water quality from the Elm Fork of the Trinity River. This blending scenario was considered to provide insight into the impact of such a diversion.

- Raw water alkalinity of about 89 mg/L and TOC of 5.7 mg/L would require TOC reduction of 35%. This water would be more easily treated than the raw water directly from Lake Palestine.

- The TOC would be in line with current levels and should not present significant DBP formation issues, especially with the use of ozone and chloramine for disinfection.

- Manganese levels would still be elevated, although less than those associated with direct use of Lake Palestine water. The additional dose of ozone required for oxidation of manganese would be approximately 0.1 mg/L.

Treatability issues related to the Baseline alternatives would result in little impact to the TRWD customers, but would impact the DWU plants (and possibly any other water treatment plants using Joe Pool Lake in one alternative). Sending Lake Palestine raw water directly to the proposed Southeast WTP, Bachman WTP, or a new WTP near Joe Pool would have the greatest impact on the cost of operating the plant and meeting regulatory requirements.

6.7.2 Interconnection Alternative 3 / Water Treatment Scenario 1 – Lake Palestine to Cedar Creek Reservoir

Under this scenario, the blended Lake Palestine and Cedar Creek Reservoir raw water would be similar to the Cedar Creek raw water currently being provided to the TRWD customers. The only constituent of potential concern in this blend, related to water treatment, is manganese. However, as discussed above in the Baseline alternatives, oxidation with ozone would be an effective treatment process for reducing the manganese level. Minimal (if any) additional ozone would be required to oxidize the manganese. The Mansfield WTP does not use ozonation as part of its treatment process. However, it does use chlorine dioxide, which is at least as effective as ozone in oxidizing manganese.

Also under this scenario, the DWU Bachman WTP or new plant near Joe Pool Lake would be provided with the same water quality as the TRWD plants from the Third Pipeline. This water quality would be similar to the DWU Baseline Alternatives 1 and 2 discussed in Section 6.4, and the same water quality and treatment issues apply.

6.7.3 Interconnection Alternative 4 / Water Treatment Scenario 2 – Lake Palestine to Lake Benbrook

Under this worst case, low probability operational scenario, raw water from Lake Palestine would feed the Fort Worth Rolling Hills WTP and future Westside WTP. The Lake Palestine water would be similar to the more difficult Cedar Creek Reservoir water that the Rolling Hills WTP sometimes receives, except for the elevated iron and manganese levels. The treatability issues would be the same as those presented in the DWU Baseline alternative with low alkalinity, high TOC and elevated manganese levels. Additional coagulation chemicals would likely be required to treat this water. The ozonation process, in place at the Rolling Hills WTP, should oxidize the manganese for removal in the sedimentation and biological filtration processes of the plant. Under this scenario, the future Fort Worth Southwest WTP could also receive Lake Palestine raw water directly from the Southern Pipeline.

6.8 Summary and Conclusions

Integrating Lake Palestine water into the DWU and TRWD raw water supply systems would have a low to moderate impact on water quality and treatment at the existing and proposed water treatment plants. The major impacts of the Lake Palestine water relate to its low alkalinity, high TOC, and high manganese concentrations.

Implementing the Baseline alternatives would create no impact to water quality or treatability at the existing plants currently being served by TRWD since the supply sources would be the same (except for the planned implementation of the constructed wetlands project). The DWU Baseline alternative, with Lake Palestine water exclusively, would result in raw water at the proposed Southeast WTP, new WTP near Joe Pool Lake, or the Bachman WTP that is more difficult to treat when compared to the City's existing Bachman WTP. The low alkalinity would require greater amounts of coagulant for treatment. The higher TOC level would present more difficulty in meeting DBP requirements. The low alkalinity coupled with the relatively high TOC would require greater TOC reduction and most likely greater coagulant use. The high manganese levels would require greater, although not significant, ozone use for oxidation and removal of manganese. Although the Lake Palestine water is anticipated to be more difficult to treat, the overall treatment process could be similar to the current DWU plants, like Bachman WTP. The operational costs would be slightly greater due to increased ozone and coagulant requirements.

Implementing water quality scenario 1 in Interconnection Alternative 3 (described in Section 6.7.2) presents no major water quality issues that would adversely impact treatability or require significant increases in operational costs. The only constituent of concern is manganese, and it could be mitigated either through blending controls or oxidized through the current plant treatment processes.

The less probable water quality scenario 2 in Interconnection Alternative 4 (described in Section 6.7.3) results in the least favorable water quality for TRWD customer plants and presents the most treatability concerns of the integrated water quality scenarios and is provided as a "worst" case. The Fort Worth Rolling Hills and Westside WTPs could seasonally be provided with water with low alkalinity, high TOC, and relatively high manganese levels. Although the ozonation processes at both plants would oxidize the manganese, it would require closer management to effectively monitor and control the process and would result in greater costs for operation. This water quality scenario also could provide the proposed Fort Worth Southwest WTP with Lake Palestine raw water.

Section 7
Permitting and Regulatory Review

7.1 Introduction

This section presents a summary of the water rights and regulatory considerations for the various facilities considered in this Project Viability Assessment and as such represents a "fatal flaw" and due diligence review for this conceptual analysis.

7.2 Water Rights

7.2.1 Lake Palestine

- The Lake Palestine water right fully authorizes the interbasin transfer of up to a total of 132,337 ac-ft/yr from the Neches River Basin into the Trinity River Basin for municipal and industrial use, with no restrictions on where the water can be used or by whom.

- Any water diverted to the Trinity River Basin from the 18,000 ac-ft/yr of industrial water that is authorized for diversion from the Downstream Diversion Reservoir under the Lake Palestine water right that is not consumed must be returned "to an unnamed tributary of Cedar Creek, tributary of Trinity River" to one of two locations specified in Paragraph 7 of the Certificate of Adjudication. This means that most, if not all, of the diversions to the Trinity River Basin under the Lake Palestine water right should come from Lake Palestine.

- The maximum diversion rate for diversions from Lake Palestine is 518 cfs, which may limit how much water can be diverted to the Trinity River Basin when considered with other diversions that are made from the reservoir for other water users and customers of the Upper Neches River Municipal Water Authority.

- The priority dates for the interbasin transfer of water from Lake Palestine to the Trinity River Basin are relatively junior (1972 and 1983), compared to the primary priority date for impounding and using water in Lake Palestine (1956).

- None of the existing reservoirs in the Trinity River Basin being considered as potential terminal storage reservoirs for the Lake Palestine water are currently authorized for such storage, including Cedar Creek Reservoir, Richland-Chambers Reservoir, Lake Benbrook, Eagle Mountain Lake, and Joe Pool Lake.

- Lake Benbrook on the Trinity River Clear Fork and Eagle Mountain Lake on the Trinity River West Fork are authorized to store water delivered from Cedar Creek and Richland-Chambers Reservoirs.

- New water rights permits or amendments to existing reservoir water rights in the Trinity River Basin will be required to authorize the storage and use of Lake Palestine water by the City of Dallas and the Tarrant Regional Water District.

- The use of Joe Pool Lake for terminal storage of the Lake Palestine water will require contractual agreements with the U. S. Army Corps of Engineers (reservoir owner) and the Trinity River Authority (water right owner).

- The use of natural stream courses for conveying Lake Palestine water to storage reservoirs or end users in the Trinity River Basin will require "bed and banks" permits from the Texas Commission on Environmental Quality.

- Authorization for the indirect reuse of return flows from the use of Lake Palestine water for municipal or industrial purposes will need to be included in water rights permits associated with the Project.

7.2.2 Cedar Creek Reservoir

- Cedar Creek Reservoir is authorized to receive water from the TRWD constructed wetlands project. This indirect reuse project to naturally treat wastewater return flows is expected to add 52,500 acre-feet per year to the reservoir.

7.2.3 Richland-Chambers Reservoir

- Richland-Chambers Reservoir is authorized to receive water from TRWD constructed wetlands like Cedar creek Reservoir, adding 63,000 acre-feet per year to Richland-Chambers.

7.2.4 Lake Arlington

- The amended certificate of adjudication (CA) for Lake Arlington indicates that the co-owners of Lake Arlington are the City of Arlington and Texas Utilities Electric Company. It is our understanding that the CA has been assigned from TXU US Holdings Company to ExTex LaPorte. Current ownership of the CA and the reservoir may therefore be different than indicated on the CA.

7.2.5 Lake Benbrook

- Lake Benbrook is owned by the U.S. Army Corps of Engineers and the CA is owned by TRWD which has contracted with the Corps for water supply storage. Using Lake Benbrook for terminal storage of Lake Palestine water will require approval and arrangements between the two parties. This agreement may require federal approval pursuant to the Water Supply Act.

7.2.6 Joe Pool Lake

- Joe Pool Lake is owned by the U.S. Army Corps of Engineers and the CA is owned by the Trinity River Authority. Using Joe Pool Lake for terminal storage of Lake Palestine water will require approval and arrangements between the two parties and may federal approval pursuant to the Water Supply Act. The City of Grand Prairie, City of Duncanville, Midlothian Water District, and City of Cedar Hill have contractual rights to water from Joe Pool Lake.

- **Contract/Contractual Permit/Agreement 1421**. Owned by the City of Grand Prairie. Allows diversions of 1,795 af per year for municipal and domestic uses. Issue date May 22, 1984 and priority date June 15, 1977**.**

- **Contract/Contractual Permit/Agreement 1422**. Owned by the City of Duncanville. Allows diversions of 1,197 af per year for municipal and domestic uses. Issue date May 22, 1984 and priority date June 15, 1977.

- **Contract/Contractual Permit/Agreement 1423**. Owned by the Midlothian Water District. Allows diversions of 6,662 af per year for municipal and domestic uses. Issue date May 22, 1984 and priority date June 15, 1977.

- **Contract/Contractual Permit/Agreement 1424**. Owned by the City of Cedar Hill. Allows diversions of 7,346 af per year for municipal and domestic and industrial uses. Issue date May 22, 1984 and priority date June 15, 1977.

7.3 Federal Permits

- The construction of pumping and conveyance facilities and regulating reservoirs required for delivering Lake Palestine water to the Trinity River Basin users will require a permit(s) under Section 404 of the Clean Water Act to the extent that the discharge of dredged and fill material adversely impacts United States' waters.

- The required Section 404 permit(s) may be "individual" permit(s) tailored specifically for the facilities and impacts associated with the Project or they may be "general" or "nationwide" permits provided the Project facilities and associated impacts qualify.

- Potentially available nationwide permits:

    1. No. 12 – Utility Line Construction impacting less than one-half acre of United States' water.

    2. No. 18 – Minor Discharges of Dredged or Fill Material involving less than 25 cubic yards of material and impacting less than one-tenth acre of United States' waters.

- Pipeline crossings of navigable streams as part of the Project will require a permit(s) under Section 10 of the River and Harbors Act of 1899.

- The Trinity River in the vicinity of where Project pipelines potentially would cross is classified as being navigable by the Corps of Engineers.

7.4 Application of Section 402 of the Clean Water Act to the Transfer

Section 402 of the Clean Water Act authorizes the NPDES ("National Pollutant Discharge Elimination System"). The NPDES permit program regulates point sources

of pollutant discharges into the waters of the United States. Whether transfers of water such as the envisioned interbasin transfers should be subject to Section 402 has been the subject of extensive litigation. The U.S. Supreme Court addressed this question in 2004 and found that current law requires an NPDES merely for the conveyance of a pollutant from one hydrologically distinct basin to another. *South Florida Water Management Dist. V. Miccosukee Tribe of Indians, 541 U.S. 95 (2204).* More recently, the Second Circuit Court of Appeals found that NPDES permits are required for interbasin transfers. *Catskill Mountains Chapter of Trout Unlimited, Inc. v. City of New York,* 451 F.3d 77 (2nd Cir. 2006)

The EPA subsequently proposed an amendment to the Clean Water Act regulations on June 9, 2006 that would expressly exclude water transfers (including interbasin water transfers) from regulation under the NPDES program. The EPA adopted the final rule declaring that routine transfers of water from one water body to another are not subject to NPDES permitting requirements this June 9, 2008. This rule defines a routine transfer as an activity that conveys waters without subjecting the water to intervening industrial, municipal, or commercial use. The water transfer rule codifies the former EPA interpretation that permits are not required for transfers such as routing water through tunnels, channels, or natural stream courses for public supplies, irrigation, power generation, flood control and environmental restoration. Pollutants introduced by the water transfer activity itself to the water being transferred would still be subject to permitting under the new rule.

The final rule is effective 60 days after it is published in the Federal Register, which is anticipated will be quite soon. If the rule is finalized in its present form, we do not believe a NPDES permit will be required from the Texas Commission on Environmental Quality for the transfer.

7.5 State Permits

Several state permits or agency approvals may be necessary either in conjunction with publicly-funded, or even with privately-funded, project financial sources. Publicly-funded projects often require agency coordination with key federal, state, and regional agencies. This agency coordination is usually performed in conjunction with the National Environmental Policy Act of 1969 (NEPA) and requires coordination with federal agencies and also the key state agencies introduced below. Even those projects that will not seek federal funding may also be impacted by some of the entities listed below, such as projects occurring near impaired water bodies or possibly by other means, as are described below.

- The Texas Commission on Environmental Quality (TCEQ) permitting could impact any project location if it is not adequately pre-screened through Phase I Environmental Site Assessment (ESA) investigation to verify that no contaminated air, water, or waste media are known to exist as recognized environmental conditions at a proposed site. For instance, Total Maximum Daily Load (TMDL) considerations need to be evaluated with respect to known TMDL waterways and also for those potential TMDL stream segments that are soon to be designated and

implemented, in some cases for additional parameters.

Segment 0805 Upper Trinity River, the segment that encompasses the Trinity River from near the confluence of the Elm Fork Trinity River in western Dallas County down to Cedar Creek Reservoir, is classified as impaired by PCBs (bio-accumulated in fish tissue). Segment 0805 is also under recent consideration for a potential bacterial TMDL. Some of the lakes listed above, like Joe Pool Lake and Cedar Creek Reservoir, could be affected by such regulatory action and this needs to be evaluated before any final sites are determined for an inter-basin transfer from Lake Palestine.

Segments 0805 and 0841 (Trinity River) in Dallas and Tarrant Counties are also under the TMDL project for legacy pollutants (such as chlordane, DDT, DDE, dieldrin, heptachlor epoxide, and PCBs in fish tissue) that is under implementation for the Trinity River and the Mountain Creek Lake.

- Texas Historical Commission (THC) is the home to the Texas State Preservation Office (TSPO) that is located in the Capitol Complex north of the Texas Capitol building. The THC is tasked with to preserve the historical, archaeological, architectural, and cultural resources that are protected by state and federal antiquities laws. Federally-funded and even state-funded projects will normally require that the study of proposed sites have a Phase I pedestrian archaeological investigation. At a minimum, proposed sites should have a desktop study of the THC website, to see if any listings are registered for a site or in its direct proximity.

- Texas Parks and Wildlife Department (TPWD) is the state agency that is committed to the preservation and protection of the state's floral and faunal species, in conjunction with the US Fish and Wildlife Service (USFWS). As such, TPWD typically agrees with the lead taken by USFWS for animal species; however, they take the lead for the protection of any protected plant species that might be impacted by the proposed project.

- Texas Water Development Board (TWDB) is the agency that manages the state's regional water planning program. Dallas Water Utilities and Tarrant Regional Water District are both located in Region C, the North Central Texas planning region. Lake Palestine is situated in Region I, the East Texas regional water planning group. Coordination between these Regional Water Planning groups has identified the potential inter-basin transfer of Lake Palestine water from Region I to Region C to satisfy the needs of the Dallas-Fort Worth metropolitan region as early as the Texas Water Plan 2002.

7.6 State Draft Nutrient Regulation

The Texas Commission on Environmental Quality (TCEQ) in conjunction with the U.S. Geological Service (USGS) is currently evaluating options for developing nutrient criteria for consideration by the U.S. Environmental Protection Agency (EPA) and the public during the next triennial revision of the Texas Surface Water Quality Standards (Chapter 307 in Title 30 of the Texas Administrative Code). Texas has no such numerical criteria currently but does address nutrient loadings by applying narrative criteria for permitted discharges by developing watershed rules which require nutrient reductions in wastewater discharges in or near specified water bodies, and by employing TCEQ's anti-degradation policy to increases in discharge loads of nutrients.

For assessing water bodies and regulatory actions, the TCEQ is also evaluating a "weight of evidence" approach to incorporate historical monitoring data for total phosphorous and total nitrogen for individual water bodies. The evaluation of permitted discharges could be based on screening criteria developed from historical data of all of these variables, in addition to the criteria listed in the water quality standard, such as chlorophyll *a*.

TCEQ has formed and is working with a Nutrient Criteria Development Workgroup in order to obtain stakeholder input from state and federal agencies, Texas river authorities, cities, industry, environmental groups, agricultural and other interested parties. Reservoirs have been the TCEQ staff's initial priority. Draft numerical nutrient criteria for the supply and receiving reservoirs considered in this initial viability assessment, as well as for lakes across the state, were provided to the Texas Surface Water Quality Standards Workgroup at their May 5, 2008 meeting.

Procedures to assess standards compliance with monitoring data will be established in both Section 307.9 of the *Texas Surface Water Quality Standards* and the *TCEQ Guidance for Screening and Assessing* Texas Surface Water and Finished Drinking Water Quality Data. Procedures to assess and set loading limits on nitrogen and phosphorus from regulated sources, such as permitted wastewater discharges, will be established in the TCEQ Procedures to Implement the Texas Surface Water Quality Standards.

While these nutrient regulations are still in the draft stages with TCEQ and do not currently apply to the inter-basin transfer of Lake Palestine water to the reservoirs evaluated in this study, all water supply agencies should be closely monitoring this developing regulatory program. Subsequent studies of the efficacy of an integrated raw water transmission system approach between TRWD and DWU will address this developing regulatory program.

Section 8
Dallas Water Utilities Additional Treatment and Water Transmission Facilities

8.1 Introduction

The purpose of this portion of the study was to consider additional cost and treatment implications for transmission of raw water to DWU treatment and distribution system facilities from project conveyance Alternatives 1 and 3, which respectively represent the independent and interconnected raw water transmission system (see **Table 1-1** for a full description of these alternatives). These additional treatment and water transmission facilities that may be required for a fully functional integrated strategy for DWU were beyond the initial study boundary (see **Figure 1-3**); therefore, costs implications in this section are additive to the DWU project conveyance alternative costs. These costs do not include distribution system improvements needed downstream of the water treatment plants. This study of three additional treatment and transmission scenarios (see **Table 8-1**) was guided by the following objectives:

1. Document the criteria that will be used in subsequent phases to select the preferred treatment/transmission scenarios and develop a listing of the applicable constraints to these scenarios (e.g. water quality, cost, and permitting complexity).

2. Develop transmission alternatives and treatment modification costs for **Scenario 1: water delivered to or around Joe Pool Lake and conveyed to the existing Bachman Water Treatment Plant (WTP).** Planning-level treatment modifications at the existing Bachman WTP to treat the water from an integrated raw water system were also considered.

3. Develop treatment costs for **Scenario 2**: **water delivered to, and treated at, the proposed Southeast WTP (SE WTP).** In this scenario, raw water would not be conveyed to or stored in Joe Pool Lake and would instead be delivered directly to the SE WTP from the integrated raw watery transmission system. Transmission costs were not included in this scenario because they were included in Interconnection Alternative 3. Treatment costs were based on construction of the new WTP.

4. Develop treatment costs for **Scenario 3**: **a new WTP located near Joe Pool Lake.** Transmission costs were not included in this scenario because they were included in Interconnection Alternatives 3 and 4. Treatment costs were based upon construction of a new WTP near Joe Pool Lake.

Table 8-1
DWU Additional Treatment and Transmission Facilities Scenarios

DWU Scenario	Conveyance	Treatment	Project Conveyance Alternative[1]
1 Bachman WTP	Delivery to or around Joe Pool Lake and conveyance to Bachman WTP	Possible Bachman WTP Process Modifications; Elm Fork Expansion	3 (Interconnected)
2 Southeast WTP	Conveyance included in Raw Water System Integration costs	New Southeast WTP	1 (Baseline)
3 WTP at Joe Pool	Conveyance included in Raw Water System Integration costs	New Joe Pool Lake WTP	3 (Interconnected)

8.2 Evaluation Criteria

In this section, evaluation criteria relate to the selection of a preferred route for transmission of water to the Bachman WTP and the estimation of costs (both capital and life-cycle) for transmission, new water treatment plants, and modifications or expansions to existing plants. This section describes criteria specific to this analysis and any differences between these criteria and those employed in other analyses in this report.

8.2.1 Transmission Infrastructure

A preliminary facility siting constraints analysis is described in Section 4 of this report to identify potential fatal flaws to locating water transmission facilities along select pipeline corridors and to make a comparison between project conveyance alternatives. Though this same level of data collection and analysis was not applied to the transmission routes to Bachman WTP, the criteria used in subsequent phases for the selection of preferred transmission scenarios, and a listing of the applicable constraints to these scenarios.

Transmission routes for this analysis were developed using limited data collection, including aerial photography, institutional knowledge, topography, and data collected for other tasks in this study. Based on this information, a preferred route was selected for cost evaluation. The basis for the capital and life-cycle cost evaluation is the same as described in Section 3 of this report (as applied to the four project conveyance alternatives for the raw water transmission system). The discount rates and cost of debt used in this life-cycle cost analysis correlate (as shown in **Table 8-1**) with the Project Conveyance Alternative discount rates and costs of debt. For example, the DWU baseline alternative rate of 4.58% was used in Scenario 2 and a

[1] Costs for Scenarios 1 through 3 are additive to the Project Conveyance Alternatives. Cost implications to Project Conveyance Alternatives 2 and 4 are not considered separately here because they fall within the bounds of these results.

discount rate of 4.77% was used for Scenarios 1 and 3 to correlate with Project Conveyance Alternative 3.

8.2.2 Water Treatment

Water treatment plant (WTP) construction and operating costs for the three DWU additional treatment and transmission facilities scenarios were based on the following:

- Raw water quality data (developed in Sections 5 and 6);
- Treatment process scenarios developed for the projected raw water quality;
- Recent construction costs for plants with similar processes on a cost per gallon basis;
- Water treatment costs (chemicals and power) associated with treatment only from similar plants treating similar waters;
- Plant capacity of 102 mgd; and
- Operating costs on a cost per gallon basis.

The treatment process selected for comparing the three DWU additional treatment and transmission facilities scenarios is similar to the Bachman WTP process and other current treatment plants served by TRWD. The treatment process includes the following processes:

- Raw water ozonation for primary disinfection, taste and odor control, and iron and manganese oxidation;
- Conventional treatment processes of rapid mix, flocculation, and sedimentation, using ferric sulfate coagulant with coagulant aid polymer;
- Biological filtration for turbidity reduction and assimilable organic carbon (AOC) removal for biological stability;
- Chloramines for residual disinfection;
- Clearwell storage;
- Lime or caustic for pH adjustment;
- Fluosilicic acid for fluoride addition; and
- Sludge lagoons for sludge handling

.

8.3 Scenario 1 – Bachman WTP

In this analysis, Scenario 1 correlates to the cost and water quality analysis found in Project Conveyance Alternative 3 (Interconnected Third Pipeline). Costs from this scenario are additive to Alternative 3 costs and the raw water used in this scenario is the same as that in Alternative 3, a blend of Lake Palestine and Cedar Creek Reservoir water.

8.3.1 Conveyance Alternative Routes in Scenario 1

Using limited data collection, including aerial photography, institutional knowledge, topography, and data collected for other tasks in this study, five feasible transmission routes were developed to deliver water from the integrated raw water transmission system pipelines to the Bachman WTP. These alternatives (all within Scenario 1) included, closed conduit and open channel pathways, delivery to and delivery around Joe Pool Lake, and conveyance through or around Mountain Creek Reservoir. The assumed take-point from the integrated raw water transmission system was from the approximate confluence of Joe Pool Lake and the Third Pipeline (or existing two pipelines) that delivers water from Cedar Creek and Richland-Chambers Reservoirs to Lake Benbrook.

Ground elevation profiles were developed for the five alternative routes to Bachman WTP using USGS contour information. **Figure 8-1** compares centerline ground elevations of each alternative route in Scenario 1. Each alternative route terminates at the same location (Bachman WTP) but differs in the intake location:

- Alternative route A intake is at the downstream end of Joe Pool Lake;
- Alternative route B intake is at a location downstream of Mountain Creek Lake (upstream of this point it is open channel flow);
- Alternative route C flows through Joe Pool Lake and then by gravity to the Trinity River where, after mixing with Trinity River flow, it is pumped to Bachman WTP;
- The intake location of alternative route D is from the Third Pipeline (or existing pipelines from Richland-Chambers and Cedar Creek Reservoirs) on the southwest side of Joe Pool Lake; and
- The intake location for alternative route E is from the Third Pipeline (or existing pipelines from Richland-Chambers and Cedar Creek Reservoirs) on the southeast side of Joe Pool Lake.

Alternative route D traverses the longest distance from the TRWD pipelines interconnection to the Bachman WTP. In **Figure 8-1,** station 0+00 represents the intake location of this longest alternative route and station 1600+00 represents the end location at the Bachman WTP intake. The pipeline profile was taken into consideration for the comparative analysis of the five alternative routes.

Table 8-2 provides some of the considerations used to develop the five alternative routes in Scenario 1. A schematic alignment of each alternative is provided in **Figure 8-2** through **Figure 8-6**. A more complete explanation of some of the "Advantages" and "Disadvantages" listed in **Table 8-2** is given here:

- The conservation pool of Joe Pool Lake is controlled by the U.S. Army Corps of Engineers in conjunction with the Trinity River Authority (TRA), which has contracted to several local customers. At this time, no storage is available to DWU for Lake Palestine water. Conveying water through Joe Pool Lake therefore has associated permitting, storage and operational issues that will require resolution should this alternative be selected.

- The general assumption in **Table 8-2** is that mixing Lake Palestine water with the Trinity River would degrade the Lake Palestine water quality.

- Alternative E – "TRWD Pipelines to Bachman WTP - SH 360 Alternative" assumes that the SH 360 corridor has available right-of-way to accommodate a pipeline. In March 2008, the North Texas Tollway Authority met with representatives from Texas Department of Transportation's Dallas and Fort Worth districts and the North Central Texas Council of Governments (NCTCOG) to discuss agency partnering and corridor planning for SH 360. The parties agreed to meet regularly to discuss scope and agency responsibilities. A description from www.nctog.org/trans/corridor/studies.asp reads: "The recommended improvements to the SH 360 South Corridor extend from Sublett Road/Camp Wisdom Road to the proposed Dallas-Fort Worth Regional Outer Loop south of US 287, passing through the cities of Arlington, Grand Prairie, and Mansfield. From Sublett Road/Camp Wisdom Road to Debbie Lane, SH 360 is planned to include 8 general purpose toll lanes; between Debbie Lane and the Dallas-Fort Worth Regional Outer Loop, 6 general purpose toll lanes are planned. In addition, the entire corridor will include 4 continuous frontage road lanes. The improvements from Sublett Road/Camp Wisdom Road to US 287 are expected to be completed by 2015, and the improvements from US 287 to the Dallas-Fort Worth Regional Outer Loop are expected to be completed by 2025."

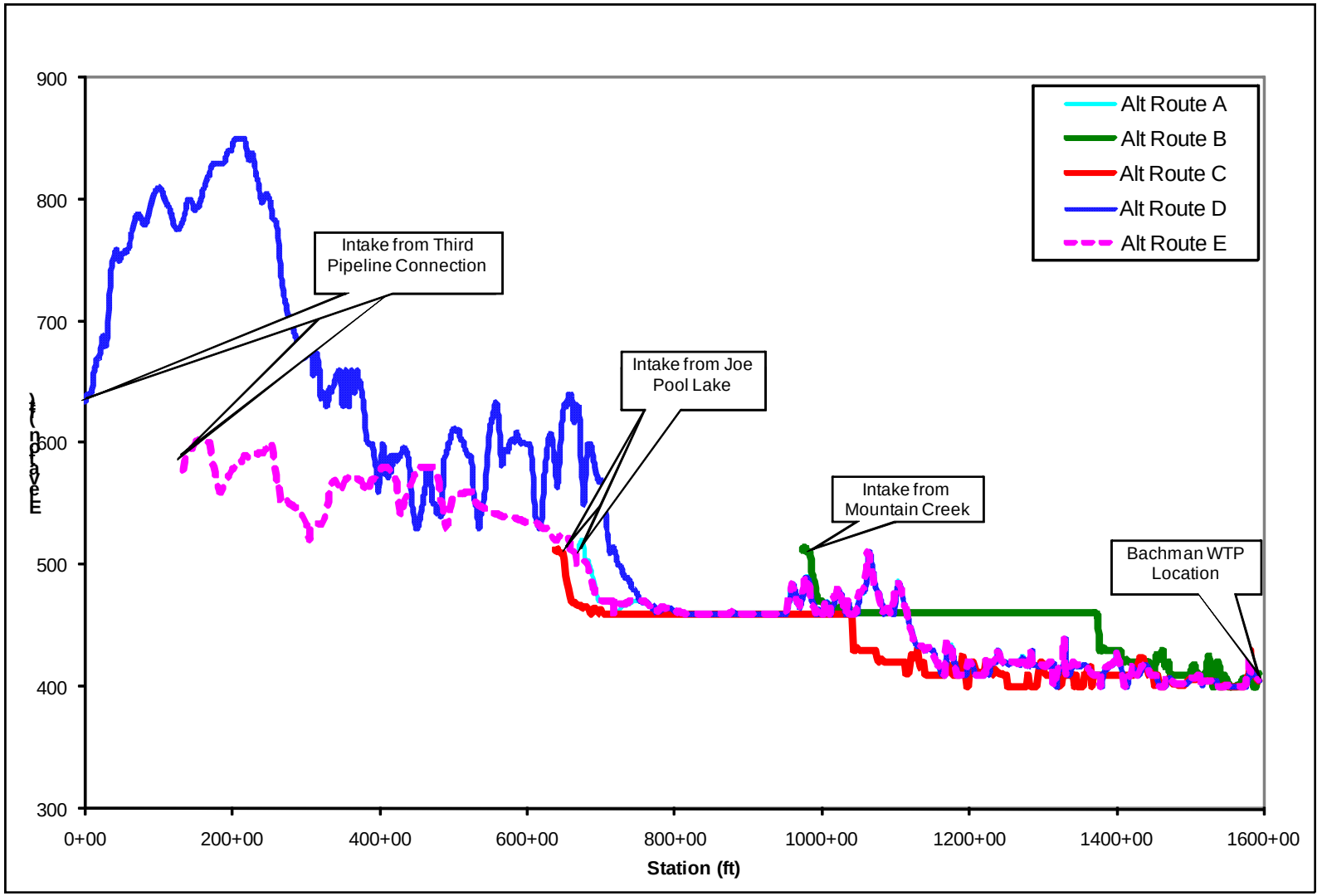


Figure 8-1
Profiles of Scenario 1 Alternative Conveyance Routes to Bachman WTP

Table 8-2
Scenario 1 Alternatives Conveyance Routes

Alternative Route	Description	Type	Pumped Flow Length (ft)	Channel Flow Length (ft)	Advantages	Disadvantages
A	Joe Pool Lake to Bachman WTP	Pumped flow	92,770 (17.6 mi)	0	Avoid potential water quality issues in the Trinity River	High pipeline and operational costs
						Joe Pool Lake permitting/storage issues
						Requires an intake facility at Joe Pool Lake
B	Joe Pool Lake to Bachman WTP	Open channel / Pumped flow	30,192 (5.7 mi)	62,294 (11.8 mi)	Potential cost benefit from reduced pipeline length	Joe Pool Lake permitting/storage issues
						Requires an intake facility on Mountain Creek
C	Joe Pool Lake to Bachman WTP	Open channel /Pumped flow	20,693 (3.9 mi)	75,192 (14.2 mi)	Potential cost benefit from reduced pipeline length	Potential water quality degradation due to Trinity River
						Joe Pool Lake permitting/storage issues
						Requires an intake facility on the Trinity River
D	Third Pipeline to Bachman WTP - Cedar Hill Alternative	Pumped flow	160,075 (30.3 mi)	0	Avoid potential water quality issues in the Trinity River	Highest pipeline and operational costs
					Avoid Joe Pool Lake permitting/storage issues	Permitting issues - pipeline corridor passes through federal & protected park lands
					Eliminate need for additional intake facility	Difficulty of obtaining easements because of urban setting
E	Third Pipeline to Bachman WTP - SH 360 Alternative	Pumped flow	146,669 (27.8 mi)	0	Avoid potential water quality issues in the Trinity River	Higher pipeline and operational costs
					Avoid Joe Pool Lake permitting/storage issues	
					Eliminate need for additional intake facility	
					Eliminate permitting issues associated with Alternative D	

Scenario 1: Transmission to Bachman WTP
Alternative Route A

Bachman Lake

Bachman WTP

Estelle Creek

Bear Creek

Delaware Creek

Elm Fork Trinity River

Trinity River

Vilbig Lakes

West Fork Trinity River

West Dallas Housing Project Lake

Bluebonnet Lakes

Texaco Lake

Coombs Creek

Cottonwood Creek

Mountain Creek Lake

Crow Creek

Kirby Creek

Artesian Creek

Mountain Creek

O'Guinn Creek

Fivemile Creek

Fish Creek

JOE POOL LAKE

Tenmile Creek

Mauk Branch

Legend

- Streets
- Rivers and Streams
- Alternative Route A

N W E S

TARRANT REGIONAL WATER DISTRICT

dallas water utilities
city of dallas

CDM/KBR

0 2,500 5,000 Feet

Figure 8-2

Scenario 1: Transmission to Bachman WTP
Alternative Route B

Bachman Lake
Bachman WTP
Estelle Creek
Elm Fork Trinity River
Delaware Creek
Trinity River
Vilbig Lakes
West Fork Trinity River
Bear Creek
Johnson Creek
Bluebonnet Lakes
Texaco Lake
Coombs Creek
Cottonwood Creek
Mountain Creek Lake
Kirby Creek
Artesian Creek
O'Guinn Creek
Fivemile Creek
Crow Creek
Mountain Creek
Fish Creek
JOE POOL LAKE

Legend

- Streets
- Rivers and Streams

Alternative Route B

- Open Channel Flow
- Pumped Flow

N
W
E
S

Tarrant Regional Water District
dallas water utilities
city of dallas

Figure 8-3

CDM/KBR

0 2,500 5,000 Feet

Scenario 1: Transmission to Bachman WTP
Alternative Route C

Las Colinas Reservoir Number 7
Estelle Creek
Joes Creek
Bachman Lake
Bachman WTP
Elm Fork Trinity River
Delaware Creek
Trinity River
Vilbig Lakes
West Fork Trinity River
Bear Creek
West Dallas Housing Project Lake
Bluebonnet Lakes
Texaco Lake
Coombs Creek
Cottonwood Creek
Mountain Creek Lake
Kirby Creek
Artesian Creek
Mountain Creek
O'Guinn Creek
Fivemile Creek
Crow Creek
Fish Creek
Mauk Branch
JOE POOL LAKE
Tenmile Creek

Legend

- Streets
- Rivers and Streams

Alternative Route C

- Open Channel Flow
- Pumped Flow

N
W
E
S

Tarrant Regional Water District
dallas water utilities
city of dallas
CDM/KBR

0 2,500 5,000 Feet

Figure 8-4

Scenario 1: Transmission to Bachman WTP
Alternative Route D

Lake Carolyn
Las Colinas Reservoir Number 7
Joes Creek
Bachman Lake
Bachman WTP
Elm Fork Trinity River
Delaware Creek
Trinity River
Vilbig Lakes
West Dallas Housing Project Lake
West Fork Trinity River
Bluebonnet Lakes
Texaco Lake
Coombs Creek
Cottonwood Creek
Mountain Creek Lake
Johnson Creek
Kirby Creek
O'Guinn Creek
Crow Creek
Artesian Creek
Fivemile Creek
Fish Creek
Mountain Creek
Mauk Branch
Woody Branch
Lynn Creek
JOE POOL LAKE
John Penn Branch
Bowman Branch
Stewart Branch
Tenmile Creek
Baggett Branch
Bentle Branch
Bee Branch
Heath Creek
Walnut Creek
Magic Valley Ranch Lake
Little Creek
Bear Creek
Low Branch
Red Oak Creek
Hollings Branch
Bedford Branch
Gifford-Hill Lake
North Prong Creek
Soil Conservation Service Site 11 Reservoir
Reece Branch
Soap Creek
Soil Conservation Service Site 1 Reservoir
Soil Conservation Service Site 10 Reservoir

0 4,000 8,000 Feet

Legend

- Streets
- Rivers and Streams
- Alternative Route D
- TRWD RC/CC Pipelines

Figure 8-5

CDM/KBR

Scenario 1: Transmission to Bachman WTP
Alternative Route E

Lake Carolyn
Lake Carolyn
Joes Creek
Bachman Lake
Bachman WTP
Elm Fork Trinity River
Delaware Creek
Trinity River
Vilbig Lakes
West Dallas Housing Project Lake
Bluebonnet Lakes
West Fork Trinity River
Texaco Lake
Johnson Creek
Coombs Creek
Cottonwood Creek
Mountain Creek Lake
O'Gunn Creek
Fivemile Creek
Kirby Creek
Crow Creek
Artesian Creek
Fish Creek
Mountain Creek
Mauk Branch
Woody Branch
Lynn Creek
JOE POOL LAKE
Bowman Branch
John Penn Branch
Stewart Branch
Tenmile Creek
Baggett Branch
Bentle Branch
Bee Branch
Heath Creek
Walnut Creek
Magic Valley Ranch Lake
Little Creek
Low Branch
Bedford Branch
Hollings Branch
North Prong Creek
Soap Creek
Gifford-Hill Lake
Soil Conservation Service Site 11 Reservoir
Soil Conservation Service Site 1 Reservoir

0 4,000 8,000 Feet

Legend

- Streets
- Rivers and Streams
- Alternative Route E
- TRWD RC/CC Pipelines

Figure 8-6

CDM/KBR

8.3.2 Conveyance Cost Analysis

The alternative route in Scenario 1 with the combination of highest probable cost and lowest probably disadvantage was selected for the conveyance cost analysis. This selection does not indicate a preference for this route but does provide the decision-maker with a result that bounds the possible cost implications. Alternative route E was selected over the other highest probable cost alternative (route D) because it does not pass through federal and protected park lands on the east of Joe Pool Lake and because it enables gravity transmission to Bachman WTP, as opposed to the higher ground elevations of Alternative D that would lead to more complicated transmission hydraulics.

Alternative route E begins at the southwest corner of Joe Pool Lake at an approximate ground elevation of 600 feet. Using a ground storage tank (GST) to serve as a balancing reservoir for the pipeline, which drops approximately 190-feet from the location of the GST to the headworks of Bachman WTP, a 78-inch pipeline enables gravity flow for the entire length of the route at a design flow of 128 MGD without the need of a booster pump station. Because alternative route E does not utilize a pump station, energy costs do not factor into the life-cycle cost analysis.

Based on the capital and life-cycle cost assumptions described in Sections 1 and 3, the opinion of capital cost for alternative route E in Scenario 1 is $171,132,000 and the Present Value of the 50-year life-cycle cost is $258,729,000.

8.3.3 Bachman WTP

In addition to the conveyance system to Bachman WTP, Scenario 1 includes treatment of raw water from Lake Palestine that has blended with Cedar Creek Reservoir water. The raw water quality for this scenario is as follows:

- Alkalinity 60 mg/L
- Hardness 5 0 mg/L
- TOC 7.0 mg/L
- TDS 132 mg/L
- Bromide 0.09 – 0.12 mg/L
- Iron 81 ug/L
- Manganese 97 ug/L

The treatment process at Bachman WTP, with projected modifications to include biological filtration, would sufficiently treat this raw water supply to meet desired water quality goals. However, due to elevated levels of TOC and manganese, additional ferric sulfate would be required to meet TOC reduction targets and

additional ozone would be required for manganese oxidation and potentially increased demand from higher organic content in the water.

Currently planned improvements to the Bachman WTP include modifications for enhanced coagulation. These improvements include additional chemical storage and feed facilities that would be sufficient for treating the higher levels of TOC associated with Scenario 1.

To facilitate oxidation of the increased levels of manganese in the Lake Palestine/Cedar Creek Reservoir blend, approximately 200 lb/day of ozone would be required. This is a small percentage of the current overall ozone capacity at the plant and existing ozone generators would likely have sufficient capacity to meet this additional requirement. Ozone generation capacity could also be increased by decreasing the ozone in oxygen concentration during periods of high flow and high ozone demand.

Because no additional facilities would be required at the Bachman WTP, the estimated capital cost is zero. The probable operating cost for Scenario 1 (chemicals and power for ozone production) is $60 per MGal treated. This evaluation assumes that the existing Bachman WTP can meet the 102 mgd capacity requirement for Lake Palestine water. However, it does not include the costs for expanding the City's overall treatment plant capacity by 102 mgd. This would likely be done by expanding the Elm Fork WTP by 102 mgd. The cost for expanding such an existing facility, if room for expansion is available, would be comparable to a new plant of the same size, approximately $200,000,000.

8.4 Scenario 2 – Southeast WTP

In this analysis, Scenario 2 correlates to the cost and water quality analysis found in Project Conveyance Alternative 1 (independent system with DWU connection to the SEWTP). Costs from this scenario are additive to Alternative 1 costs and the raw water used in this scenario (Lake Palestine only) is the same as that in Alternative 1. Scenario 2 includes treatment of raw water from Lake Palestine at the new Southeast WTP. The raw water quality for this scenario is as follows:

- Alkalinity 38 mg/L
- Hardness 48 mg/L
- TOC 8.5 mg/L
- TDS 138 mg/L
- Bromide 0.12 mg/L
- Iron 110 ug/L
- Manganese 250 ug/L

The selected treatment process (see Section 8.2.2) would sufficiently treat this raw water supply to meet target water quality goals. However, due to low alkalinity and elevated levels of TOC and manganese, the water will be more difficult to treat than the raw water from Scenario 1, and will require greater quantities of treatment chemicals. Additional ferric sulfate would be required to meet TOC reduction targets and additional ozone would be required for manganese oxidation and potentially increased demand from higher organic content in the water.

The probable construction cost for a conventional water treatment plant with ozonation facilities and onsite sludge lagoons is approximately $2.00 per gallon. This cost is based on recent (2008) construction cost bids for similar facilities. The construction cost of a new 102 mgd water treatment plant would be approximately $204 million. To account for additional ozonation facilities and chemical storage and feed facilities, this cost was increased by 5%. Therefore, the probable capital cost for the new 102 mgd Southeast WTP would be approximately $215,000,000. The probable operating cost (chemicals and power for ozone production) is $66 per MGal treated.

8.5 Scenario 3 – WTP at Joe Pool Lake

In this analysis, Scenario 3 correlates to the cost and water quality analysis found in Project Conveyance Alternative 3 (Interconnected Third Pipeline). Costs from this scenario are additive to Alternative 3 costs and the raw water used in this scenario is the same as that in Alternative 3, a blend of Lake Palestine and Cedar Creek Reservoir water. Scenario 3 includes treatment of raw water from Lake Palestine that has blended with Cedar Creek Reservoir water. It was assumed that raw water would be pulled off prior to discharge into Joe Pool Lake and treated at a new water treatment plant near Joe Pool Lake. The raw water quality for this scenario is as follows:

- Alkalinity 60 mg/L
- Hardness 50 mg/L
- TOC 7.0 mg/L
- TDS 132 mg/L
- Bromide 0.09 – 0.12 mg/L
- Iron 81 ug/L
- Manganese 97 ug/L

The selected treatment process (see Section 8.2.2) would sufficiently treat this raw water supply to meet target water quality goals. The raw water quality is the same as Scenario 1 and would require the same treatment process and treatment requirements. Therefore, the probable construction cost of a new 102 mgd water treatment plant near Joe Pool Lake would be approximately $204 million, not

including the potential cost of purchasing a treatment plant site. The probable operating costs (chemicals and power for ozone production) are $60 per MGal treated.

8.6 Mountain Creek Lake Considerations

8.6.1 Mountain Creek Lake Overview

Mountain Creek Lake was built as a cooling reservoir for a power plant originally constructed in 1938. The reservoir is still used for cooling purposes at the Mountain Creek Generating Station. This power plant is operated by Exelon Corporation according to the Exelon web site[2]. The annual use reports reviewed indicate that this plant may divert between about 120 cfs and in excess of 900 cfs for cooling and other industrial purposes. The TCEQ tabulation of water rights and documents available of record from the TCEQ do not indicate any other CA or permit holder for water from Mountain Lake. TCEQ staff confirmed that it is unlikely another CA or permit holder exists, but that there can be infrequent omissions in the TCEQ database.

Technical Data on Mountain Creek Lake

Water Right – Certificate of Adjudication 08-3408

Water Right Owner – ExTex LaPorte

Reservoir Owner – ExTex LaPorte

Stream – Mountain Creek, tributary of the Trinity River

County – Dallas County

Conservation Storage Capacity – 22,840 acre-feet

Maximum Diversion – "Owner is authorized to divert and consumptively use not to exceed 6400 acre-feet of water per annum from the aforesaid reservoir for industrial purposes."

Maximum Diversion Rate – The maximum combined rate of diversion specified in Certificate of Adjudication 08-3408, Paragraph 3.B. has been marked out in the copy received from TCEQ. No maximum diversion rate is specified in the tabulation of water rights maintained by TCEQ.

Priority Date: March 12, 1929

Environmental Flow Requirements – none indicated in materials reviewed

As with the other reservoirs we have studied on the Trinity River, the water right for Mountain Creek Reservoir does not expressly authorize surface water to be stored in the reservoir from sources outside the Trinity River basin, nor does the water right preclude such storage. The CA also did not include special provisions,

[2] ExTex LaPorte and Exelon appear to be related entities.

such as environmental flow requirements or conservation requirements for wholesale water users that would otherwise affect storage or transmission of water from outside the Trinity River basin in or through Mountain Creek Reservoir.

We note that the Mountain Creek Generating Station pumps a large amount of water from Mountain Creek Reservoir for cooling and other industrial purposes. This may cause the reservoir level to fluctuate, affect the temperature of the water in the reservoir, and otherwise affect water passing through the reservoir. The CA for the reservoir is senior to that of the Lake Palestine transfer (and most other water rights in the area), and so the transfer must be implemented so as to not affect these senior rights. The CA allows the holder to divert and consumptively use only 6,400 acre-feet of water annually. According to the annual use reports, the generating station diverted 491,230.81 acre-feet from Mountain Creek Lake in 2004, and consumed 1084.456 acre-feet. These figures are consistent with or lower than past years. Our interpretation of the diversion restriction imposed by the CA is that the power plant is currently exceeding its allowable diversions, but that these large diversions may not detrimentally affect the amount of water available to other water right holders. Any subsequent use of the reservoir by Dallas Water Utilities would need to take into account the generating station's permitted diversions rather than its current actual diversions.

See **Figure 8-7**, prepared by the City of Dallas, depicting the general location of Mountain Creek Lake and its watershed.

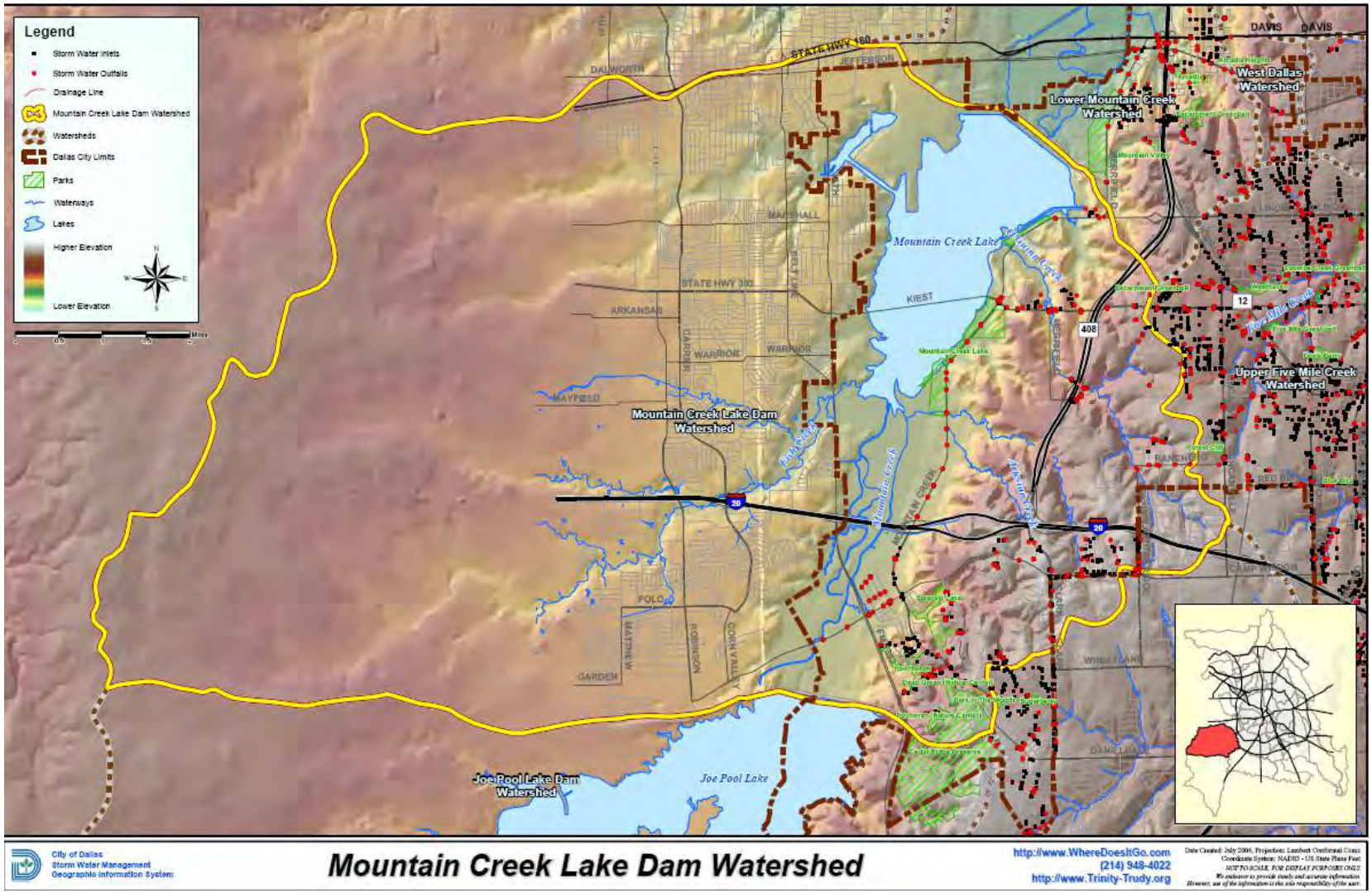


Figure 8-7
Mountain Creek Lake Dam Watershed

8.6.2 Mountain Creek Water Quality

Under one of the alternative routes in Scenario 1 discussed above, 102 mgd of the interconnected TRWD/DWU water would be routed from Joe Pool Lake through Mountain Creek Lake to the Bachman WTP. The Texas Commission on Environmental Quality (TCEQ) has identified water quality concerns in Mountain Creek Lake. The following provides a summary of the water quality concerns associated with this water body and evaluates their importance with regards to the water routing proposal.

Existing Water Quality

The following sections summarize what is known regarding existing water quality in Joe Pool and Mountain Creek Lakes.

Joe Pool Lake – Joe Pool Lake is a 7,470 acre reservoir that is protected for the following beneficial uses: Aquatic life, contact recreation, general, fish consumption and public water supply. Reservoir water quality is regularly assessed by TCEQ every two years; the latest draft assessment was completed in March 2008 (TCEQ 2008). This assessment reported that water quality in the reservoir is good with all assessed beneficial uses fully supported – including the public water supply use. The 2008 findings are consistent with assessments completed in previous years.

Mountain Creek Lake – This lake is a 2,710 acre reservoir that is protected for the following beneficial uses: Aquatic life, contact recreation, general, fish consumption and public water supply. In contrast to Joe Pool Lake, this reservoir has water quality concerns – but only as applicable to the protection of the fish consumption use (TCEQ 2008). No concerns have been identified for other beneficial uses, e.g., public water supply (TCEQ 2008).

The fish consumption advisory was issued on April 25, 1996 as result of lake studies conducted in 1994-1995 by the U.S. Geological Survey (see Van Metre et al. 2003). These studies showed elevated concentrations of PCBs, chlordane, heptachlor epoxide, and DDT (and its byproducts DDD and DDE), in sediments and fish tissue that exceeded Texas Department of Health (TDH) guidelines for the consumption of fish. Sources of these contaminants date back to activities occurring along and near the lake at the Naval Air Station Dallas and the Naval Weapons Industrial Reserve Plant, primarily from 1941 to 1974.

Changes in discharge practices and implementation of state and federal environmental laws and regulations since the 1970s have resulted in a gradual improvement in sediment quality. For example, Van Metre et al. (2003) showed substantial differences in sediment quality with sediment depth in the lake bottom. Older, deeper sediments had substantially higher levels of contaminants than newer, surficial sediments. This change demonstrates that contaminant control and

remediation activities are resulting in a greatly reduced load of contaminants to the reservoir.

Van Metre et al. (2003) identified a number of concerns regarding contaminants in fish tissue including PCBs and various organochlorine pesticides. For metals, only selenium was identified as a concern, but no concerns were identified for other organic chemicals such as polycyclic aromatic hydrocarbons (PAHs) and volatile organic compounds (VOCs).

Ultimately, the outcome from the findings of this study was the listing of Mountain Creek Lake as an impaired waterbody requiring a Total Maximum Daily Load (TMDL) to address impairment of the fish consumption use. This listing was based solely on the fish tissue data and resulting fish consumption advisory for the following contaminants: DDT, DDD, DDE, chlordane, dieldrin, PCBs and heptachlor epoxide. The listing was not based on the finding of any contaminants at levels of concern in the water column.

In June 2001, the Environmental Protection Agency approved a TCEQ adopted TMDL established, in part, to address the fish consumption impairment in Mountain Creek Lake (TCEQ, 2000). Subsequently, the TCEQ adopted a plan to implement the EPA-approved TMDL (TCEQ, 2001). This plan relies on the continued remediation of contaminant sources at source sites (e.g., Naval Air Station) to prevent any additional loadings to the lake, e.g., through the runoff of stormwater, and the passage of time to achieve compliance. As correctly noted in the TMDL, source control is critical so that no new loadings to the waterbody occur, but a key means for achieving success is to allow time for natural attenuation processes to occur.

Natural attenuation relies on the natural process of sedimentation to the lake to deposit clean sediment over contaminated sediment. Clean bottom sediments prevent contaminants from being consumed by invertebrates which are in turn consumed by fish resulting in bioaccumulation in fish tissue. Over time (many years) the result of natural attenuation will be a gradual reduction in fish tissue concentrations. The time to success will be improved the more quickly the sources of contaminants in the watershed are eliminated.

Efforts to reduce contaminant loadings have been ongoing for some time. TDH (2002) provides evidence that this process is gradually improving water quality. They note that in 1995 67 of 68 fish tissues samples contained the PCB congener Aroclor 1260. Of 10 samples collected in 2000 and 2001 Aroclor 1260 was detected in only one fish sample. Although this result suggests that water quality management efforts are resulting in water quality improvements, TDH wanted to collect more data before determining whether PCB levels were low enough to support removal of the fish consumption advisory (at least for PCBs). As of this date, the fish consumption advisory remains in place.

Water Quality Discussion and Recommendations

Based on the review of Joe Pool Lake and Mountain Creek Lake water quality data, it is unlikely that routing water through Mountain Creek Lake to Bachman WTP will result in any drinking water quality concerns. This finding is based on the following:

- Water quality in the source water (Joe Pool Lake plus Lake Palestine, or Lake Palestine/Cedar Creek Reservoir blends) is good and the blended interconnected supplies would be acceptable for drinking water uses as previously discussed in Section 5;

- TCEQ has repeatedly made a regulatory finding that water quality in Mountain Creek Lake fully supports the Public Water Supply beneficial use.

- Water quality concerns in Mountain Creek Lake are limited to sediment and fish tissue – not the water itself. These concerns are also primarily associated with the Cottonwood Bay portion of the reservoir and not the main lake.

- A TMDL has been established which is aggressively addressing contaminant loadings to the reservoir.

- Evidence exists (TDH 2002) that contamination mitigation efforts are resulting in less contamination in fish tissue.

While these findings suggest that routing water through the reservoir is a viable option with regards to water quality, the following recommendations should be considered if that option is pursued:

- Because a TMDL exists on the reservoir, this option should be discussed with TCEQ to identify any concerns that they may have. Discharging water from Joe Pool Lake to Mountain Creek Reservoir changes the dynamics of the reservoir and may need to be factored into TCEQ's TMDL implementation program.

- The TCEQ periodically assesses water quality in Mountain Creek Lake as part of the state biannual waterbody assessment process. If this reservoir becomes a source location for the Bachman WTP, the treatment facility may want to conduct additional source water sampling to supplement TCEQ's monitoring program.

8.7 Summary and Conclusions

Table 8-3
DWU Additional Treatment and Water Transmission Facilities
Summary Conclusions

Results	DWU Scenario		
	1 Bachman WTP	**2 Southeast WTP**	**3 WTP at Joe Pool**
Conveyance Capital Cost[(1)]	$171,132,000	n/a	n/a
Treatment Infrastructure Capital Cost	No Cost at Bachman WTP + Elm Fork Expansion (~$200,000,000)	$215,000,000	$204,000,000
Treatment Op. Cost (per MGal Treated)	$60	$66	$60
Present Value of 50-year Life-Cycle Cost	$782,604,000[(2)]	$572,321,000	$554,872,000
Notes	Costs for expanding DWU's overall treatment plant capacity by 102 mgd (by expanding the Elm Fork WTP if room for expansion is available) would be comparable to a new plant of the same size	Cost for conveyance is included in Project Conveyance Alternative costs	Cost for conveyance is included in Project Conveyance Alternative costs

Note (1): Distribution system costs (downstream of the WTP) are not included.

Note (2): The replacement of 102 mgd capacity at Elm Fork WTP is included in this figure. If this cost is excluded, the Present Value of the 50-year life-cycle cost is $335,572,000.

Modifications to Bachman WTP treatment process:

- Biological filtration (currently being implemented);
- Additional ferric sulfate storage and feed facilities to meet desired TOC reduction (current enhanced coagulation improvements should meet these requirements); and
- Additional ozone generation capacity (approximately 200 lb/day) for manganese oxidation (existing plant ozonation facilities should be capable of providing this increased ozone requirement)

Proposed Southeast WTP

- Due to low alkalinity and elevated levels of TOC and manganese, the water would be more difficult to treat than the raw water from Scenario 1 (at Bachman WTP);
- Additional ferric sulfate addition would be required to meet desired TOC reduction; and

- Additional ozone would be required for manganese oxidation and due to increased demand from higher organic content in the water.

Proposed Joe Pool Lake WTP: raw water quality would be the same as that for Scenario 1 (at Bachman WTP) and would require the same treatment process and treatment requirements.

Mountain Creek Lake

The Mountain Creek Lake water right does not expressly authorize surface water to be stored in the reservoir from sources outside the Trinity River basin, nor does the water right preclude such storage. The Certificate of Adjudication also does not include special provisions, such as environmental flow requirements or conservation requirements for wholesale water users that would otherwise affect storage or transmission of water from outside the Trinity River basin in or through Mountain Creek Lake.

Based on the review of Joe Pool Lake, Lake Palestine, Cedar Creek Reservoir and Mountain Creek Lake water quality data, it is unlikely that routing water through Mountain Creek Lake to Bachman WTP will result in any significant drinking water quality concerns. These findings suggest that the option to route water through Mountain Creek Lake is a viable option with regards to drinking water quality.

Section 9
Preliminary Findings and Recommendations

9.1 Preliminary Findings

The purpose of this initial Project Viability Assessment and Business Case Evaluation was to 1) identify any "fatal flaws" to developing an integrated raw water transmission system; and 2) compare the separate, independently adopted water strategies of both TRWD and DWU with integrated raw water delivery system alternatives in terms of their life-cycle cost implications, water quality and treatment implications, and permitting and environmental issues. Six tasks were completed as part of this initial Project Viability Assessment and Business Case Evaluation.

1. Integrated system operations analysis;
2. Capital and life-cycle cost analysis;
3. Facility siting constraints assessment;
4. Environmental water quality review;
5. Consideration of water treatment impacts; and
6. Permitting and regulatory review.

At the outset of this initial Project Viability Assessment and Business Case Evaluation, the project team recognized that separate, sound water management strategies are already in place for both DWU and TRWD and that any integrated, joint-agency approach would need to meet several key objectives to complement or replace existing plans:

- An integrated raw water transmission system alternative must enhance the redundancy, flexibility, and demand risk management of the existing water supply systems;
- An interconnected plan must make sufficient water supply available to meet demands where and when needed, under a full range of historical hydrological conditions;
- An integrated raw water transmission system alternative must reduce capital and life-cycle costs, while not contributing to unmitigated treatment or distribution costs for DWU or TRWD customers; and

- All scenarios must fully consider societal, environmental, and regulatory complexities

With these key objectives guiding the way, four project conveyance alternatives were developed through a progressive screening approach to evaluate combinations of conveyance infrastructure and interconnections. Two Baseline Alternatives (independent water strategies) and the two most promising Interconnection Alternatives (integrated delivery systems) were then selected (as described in **Table 1-1** and repeated below for the reader's convenience). Key findings from the six tasks as they relate to the objectives listed above are here presented based on the analysis of these four project conveyance alternatives.

Alternative	Description
1 (Baseline)	Independent Systems: TRWD's East Texas Third Pipeline and DWU's connection of Lake Palestine to the proposed Southeast Water Treatment Plant
2 (Baseline)	Independent Systems: TRWD's East Texas Third Pipeline and DWU's connection of Lake Palestine to Joe Pool Lake
3 (Interconnection)	Integrated System: Interconnected Third Pipeline (upsized as compared to the baseline condition) with connection of Lake Palestine to Cedar Creek Reservoir and delivery to DWU at Joe Pool Lake and TRWD's customers through the Third Pipeline
4 (Interconnection)	Integrated System: Interconnected "Southern Pipeline" - Lake Palestine delivered to the Lake Benbrook pipeline via a pipeline route to the south of the TRWD Third Pipeline route. Delivery to DWU at Joe Pool Lake and TRWD's customers through connections to the existing system and the Lake Benbrook pipeline.

9.1.1 Conclusions from Integrated Operations Analysis

The purpose of this analysis was to identify opportunities for benefits, or potential disadvantages, to both TRWD and DWU through integrated operations of the raw water transmission systems from Lake Palestine, Richland-Chambers Reservoir, and Cedar Creek Reservoir. This comparison of Baseline Alternatives 1 and 2 with Interconnection Alternatives 3 and 4 (see Table 1-1) was driven by a system operations model and the team's water resource planning experience. This model was formulated as a decision-support system that permitted the user to create an array of scenarios that help answer a series of primary and secondary questions, formulated jointly by the project participants during workshops:

In this context, we can conclude the following regarding operating costs, water sharing and timing, redundancy, flexibility, and regional cooperation:

9.1.2 Operating Costs

The integrated operations modeling shows that operating costs within the bounded system are lower in interconnected alternatives as compared to baseline alternatives. This opportunity for operational cost savings is more pronounced in the near term and decreases over time as the difference between interconnected and independent

operations is minimized. This near-term savings is attributed to the fact that the full amount of DWU water supply from Lake Palestine is not required immediately. (DWU access to the TRWD supply system could extend the need to connect the Lake Palestine supply to each system.)

9.1.3 Water Sharing and Timing

The integrated operations modeling found that there is opportunity to make extra water available to water user groups via an interconnected system. The analysis suggests that even under drought conditions in 2020, approximately 80 additional mgd could be available. This result is based on three modeling protocols: 1) water availability is limited by existing TRWD permits (for Richland-Chambers, Cedar Creek, and the planned wetlands); 2) DWU demand is equal to the contracted amount in Lake Palestine (102 mgd); and 3) conveyance is limited by the capacity of existing and planned TRWD conveyance facilities.

This result also confirms that Lake Palestine supply will be required prior to 2020 if the DWU demand reaches 102 mgd (though not all of it will be required immediately and dependence upon it as a source could conceivably be phased). Additions to conveyance capacity could be phased through 2030. TRWD requires water supply in addition to sources already included in the model, such as the constructed wetlands, between 2030 and 2040 (based on existing permit constraints and projected demands).

Interconnection also provides the opportunity for TRWD to use the 102 mgd from Lake Palestine. This water sharing may be useful in an emergency situation or in a localized drought condition that causes deficit in the TRWD system while excess is available to DWU. This opportunity to share water between the two water providers is also a method of demand risk management to mitigate the effects of unforeseen demand growth patterns in the TRWD or DWU systems.

By the year 2030, any configuration of the system becomes supply limited, and reliability predictions during severe droughts would be roughly equivalent among configurations. However, during normal hydrologic periods, extra supply is available through 2060 in an interconnected system, though TRWD may have conveyance limitations to accessing the water. The analysis also indicates that the TRWD system can support sustained withdrawals above the current permitted levels. In other words, supply is limited by the permitted amounts, not water availability.

With an interconnected system, any additional water above projected demands would conceivably be available to any water user group, provided that conveyance capacity would be adequate. With separate systems, this water would not be available to DWU and TRWD and its customers would not benefit from potential sales or trades of water above projected TRWD customer demands. With an interconnected system, there is also the possibility of bringing other, currently independent sources (such as DWU reuse water) and new water supply sources (Toledo Bend, Oklahoma, etc.) into the interconnected system to enhance the potential for water sharing.

To satisfy the DWU demands as they are represented in the model, the full yield of Lake Palestine (102 mgd) is needed immediately if the two systems remain separate. If conveyance systems are interconnected, use of Lake Palestine could ramp up gradually (assuming TRWD water supply in excess of projected demands could help satisfy DWU demand). This offers significant benefits with respect to phased infrastructure that are not available with separate systems.

9.1.4 Redundancy

Operational redundancy is a "belt and suspenders" approach to risk management that enables the water supplier to select from multiple supply sources in times of emergency, drought, failure, etc. An interconnected supply system therefore provides more opportunity for supply and failure risk management.

In the event of a pipe failure or power outage, an integrated transmission system has more alternative flow pathways and connections to multiple water and power sources. These additional connections lower risk to the water provider. The impacts of climatic variations are also lessened because of the diversification of reservoir locations. An interconnected system "casts a wider net" to reservoirs in different watersheds that will potentially experience drought in different times or levels of severity. Also, access to additional sources that may not be fully utilized adds supply redundancy to the system.

9.1.5 Operational Flexibility

Under prevailing ("normal") hydrologic conditions when the modeled system is not supply-limited, an interconnected system offers more operational flexibility than separate sources, since multiple flow pathways could be used to transport water. Such flexibility could be used to capitalize on advantageous opportunities for blending of sources, pump cycling schedules, system maintenance and energy management. One potential disadvantage of operations in an integrated system is the potential for increased operational complexity and the attendant new systems and protocols that must be developed to manage such a system.

The interconnected system also provides flexibility in terms of water availability. Extra supply is available through 2060 in an interconnected system and the analysis indicates that the TRWD system can support sustained withdrawals above the current permitted levels. This ability to overdraft supply sources provides flexibility to system operations, the potential for lower operating costs, and risk mitigation.

The National Water Research Institute in its November 2007 white paper entitled "Water 2010: A 'Near Sighted' Program of Water Resource Management Improvements for the Western United States" recommended system interties as its number one action item for state and local policymakers. NWRI concluded that "System interties increase the flexibility of system operators to respond to weather events, natural disasters, contaminations incidents, or the need to take water treatment or conveyance facilities temporarily off-line for repair or

refurbishment……many interconnections can be planned and constructed within just a few years and at a relatively low cost."

9.1.6 Regional Cooperation

TRWD and DWU have a long history of cooperation in water supply planning, including the Texas Water Development Board regional water planning efforts initiated by the 1997 passage of Senate Bill 1 in the 75th session of the Texas Legislature. This on-going cooperation has led to this study and the potential for raw water transmission system interconnection. The interconnection of the two systems provides opportunities for benefit to both agencies by laying the groundwork for interconnecting future water supply sources (Toledo Bend, Oklahoma, etc.), increasing the portfolio of water supply options, reducing the costs of right-of-way through earlier acquisition, providing financing risk management, and compliance with TWDB planning guidelines.

The groundwork for regional cooperation in accessing future water supply options has already been laid; integrated water supply infrastructure provides additional opportunity for cost savings and will facilitate future inter-local agreements. By interconnecting the transmission system, each agency also effectively increases its portfolio of water supply options through the potential to share water and infrastructure.

Escalating costs for right-of-way acquisition (and urbanization) also point to the benefits of securing transmission routes early. This early acquisition presents an opportunity to acquire sufficient right-of-way for future joint water supplies. TRWD has recently experienced the following average costs for securing easements for several large diameter transmission system projects, costs which raise the issue of expedited acquisition of right-of-way for this and other future joint projects:

- Real estate classified as rural - $15,415 per acre.
- Real estate classified as undeveloped, planned - $33,792 per acre.
- Real estate classified as developed - $71,247 per acre.

Escalation in the cost of materials and ever increasing pressure on the financing market also point to the benefits of interconnection. Economies of scale and the ability to leverage the joint financing capacity of both agencies are benefits in integration.

Along with the other opportunities for benefits through integration, this regional cooperation is in compliance with TWDB guidelines for water supply planning. These guidelines and the TWDB planning process require this cooperation.

9.1.7 Summary of Integrated Operations Conclusions

From an operational perspective, the analysis supports further investigation of interconnected conveyance alternatives. Unlike separate systems, an interconnected system that routes Lake Palestine through the planned TRWD system offers reduced operating costs, cost sharing, savings due to infrastructure phasing, opportunities for water sharing, the potential for increased overall system yield and supply reliability, redundancy, and operational flexibility with respect to infrastructure scheduling and daily operations.

These results indicate a broad range of potential benefits that could be realized with an interconnected system as opposed to separate systems. Subsequent sections of this report address other factors relevant to interconnections, such as water quality, treatment requirements, environmental impacts, etc. Subsequent phases of work will establish operating protocols and cost agreements for shared conveyance and shared supply, and will address permitting needs.

9.1.8 Lifecycle Cost Analysis

Results from this screening level cost analysis show that there are opportunities for significant cost savings through integrated conveyance system alternatives to deliver DWU and TRWD supplies. Delivering water through an Interconnected Third Pipeline has potential Present Value, 50-year lifecycle cost savings between approximately $220,000,000 and $540,000,000.

The Interconnected Southern Pipeline alternative has potential Present Value, 50-year life-cycle cost savings when compared to Alternative 2 (baseline with delivery to Joe Pool) but increased cost when compared to Alternative 1 (baseline with delivery to SE WTP). However, because the Interconnected Southern Pipeline delivers water to Joe Pool Lake and not the SE WTP, the most direct comparison is between the Interconnected Southern Pipeline and Alternative 2, which results in an approximate $36,600,000 savings. Subsequent phases of this feasibility assessment will consider other potential benefits from the Southern Pipeline, such as supply risk reduction and right-of-way acquisition for future supplies. Escalating costs raise the issue of expedited acquisition of right-of-way (e.g. in the Southern Pipeline route) to manage the availability and cost of acquisition for this and future water supplies from East Texas. Also, phasing could also result in significant reduction of costs associated with the Interconnected Southern Pipeline due to the potential to defer development of transmission facilities required to deliver water to Lake Benbrook.

9.1.9 Environmental Water Quality and Water Treatment

Integrating Lake Palestine water into the DWU and TRWD raw water supply systems will have a low to moderate impact on environmental water quality and treatment at the receiving reservoirs and at the water treatment plants. The major impacts of the Lake Palestine water on water treatment relate to its low alkalinity, high TOC, and high manganese concentrations. The importation of Lake Palestine water will result in higher nutrient levels at the studied receiving reservoirs but will not likely to lead

to impacts that impair the designated uses of the water bodies. Additional studies will help predict the complex kinetic relationships between nutrients and chlorophyll-a, particularly for those reservoirs where additional water management strategies include supply augmentation with reuse water.

9.1.10 Ellis and Johnson Counties

The Region C Four County Study (by Freese & Nichols, Inc.) concluded that population and demand projections are exceeding those included in the 2006 Region C water plan. Both TRWD and DWU have existing and projected wholesale customers in Ellis and Johnson Counties to be served by the integrated conveyance systems analyzed in this study. Further development of the raw water transmission integration alternatives will allow TRWD and DWU to consider how these demands can be jointly met in terms of supply, infrastructure and contractual agreements, including advancement of the Trinity River Authority Ellis County Water Supply Project recommended in the Region C Water Plan.

9.1.11 DWU Additional Treatment and Transmission Facilities

This task considered additional cost and treatment implications for transmission of raw water to DWU treatment and distribution system facilities from project conveyance Alternatives 1 and 3, which respectively represent the independent and interconnected raw water transmission system. These additional treatment and water transmission facilities that may be required for a fully functional integrated strategy for DWU were beyond the initial study boundary; therefore, costs implications in this section are additive to the project conveyance alternative costs. These costs do not include distribution system improvements needed downstream of the water treatment plants.

Table 9-1
DWU Additional Treatment and Transmission Facilities

Results	DWU Scenario		
	1 Bachman WTP	**2 Southeast WTP**	**3 WTP at Joe Pool**
Conveyance Capital Cost(1)	$171,132,000	n/a	n/a
Treatment Infrastructure Capital Cost	No Cost at Bachman WTP + Elm Fork Expansion (~$200,000,000)	$215,000,000	$204,000,000
Treatment Op. Cost (per MGal Treated)	$60	$66	$60
Present Value of 50-year Life-Cycle Cost	$782,604,000(2)	$572,321,000	$554,872,000
Notes	Costs for expanding DWU's overall treatment plant capacity by 102 mgd (by expanding the Elm Fork WTP if room for expansion is available) would be comparable to a new plant of the same size	Cost for conveyance is included in Project Conveyance Alternative costs	Cost for conveyance is included in Project Conveyance Alternative costs

Note (1): Distribution system costs (downstream of the WTP) are not included.
Note (2): The replacement of 102 mgd capacity at Elm Fork WTP is included in this figure. If this cost is excluded, the Present Value of the 50-year life-cycle cost is $335,572,000.

Modifications to Bachman WTP treatment process

- Biological filtration (currently being implemented);
- Additional ferric sulfate storage and feed facilities to meet desired TOC reduction (current enhanced coagulation improvements should meet these requirements); and
- Additional ozone generation capacity (approximately 200 lb/day) for manganese oxidation (existing plant ozonation facilities should be capable of providing this increased ozone requirement)

Proposed Southeast WTP

- Due to low alkalinity and elevated levels of TOC and manganese, the water would be more difficult to treat than the raw water from Scenario 1 (at Bachman WTP);
- Additional ferric sulfate addition would be required to meet desired TOC reduction; and

- Additional ozone would be required for manganese oxidation and due to increased demand from higher organic content in the water.

Proposed Joe Pool Lake WTP: raw water quality would be the same as that for Scenario 1 (at Bachman WTP) and would require the same treatment process and treatment requirements.

Mountain Creek Lake

The Mountain Creek Lake water right does not expressly authorize surface water to be stored in the reservoir from sources outside the Trinity River basin, nor does the water right preclude such storage. The Certificate of Adjudication also does not include special provisions, such as environmental flow requirements or conservation requirements for wholesale water users that would otherwise affect storage or transmission of water from outside the Trinity River basin in or through Mountain Creek Lake.

Based on the review of Joe Pool Lake, Lake Palestine, Cedar Creek Reservoir and Mountain Creek Lake water quality data, it is unlikely that routing water through Mountain Creek Lake to Bachman WTP will result in any significant drinking water quality concerns. These findings suggest that the option to route water through Mountain Creek Lake is a viable option with regards to drinking water quality.

9.2 Triple Bottom Line Business Case Evaluation

The project findings can be briefly summarized in terms of a comparison of positive or negative impacts of interconnection alternatives vs. baseline plans as shown in **Table 9-2** in a Triple Bottom Line Matrix.

Table 9-2
Triple Bottom Line Matrix
Comparison of Interconnection and Baseline Alternatives

Project Element	Economic	Environmental	Social
Capital Costs	+		
Life-cycle Cost	+		+
Water Treatment Implications	–		
Permitting/Constraints	+	–	
Environmental Water Quality		–	
Water Sharing and Timing, Redundancy, Flexibility	+	+	
Regional Cooperation and Future Water Supply	+	+	+
Ellis County Service			+

9.3 Recommendations

This initial feasibility study was tasked with assessing the "fatal flaws" and "business case" for a joint, integrated regional approach to water supply and raw water transmission. The findings of this study identify the economic, social and environmental potential of such a project, and clearly suggest that the prospect of interconnecting Lake Palestine through the TRWD system offers benefits that warrant further consideration.

Conceptual engineering and operational scenarios were analyzed in this effort; further analysis is needed to more fully develop how such a joint project would be planned, designed and operated to optimize economic and operational benefits to both systems. This subsequent effort must be initiated quickly due to impending supply constraints and is paramount to support development of institutional agreements and a financing strategy that will be required.

9.3.1 Conceptual Design Phase

It is recommended that TRWD and the City of Dallas proceed to a Conceptual Design Phase. The purpose of this second phase is to further develop:

- The conveyance alternatives (with more detailed hydraulic and operational analysis);
- The phasing potential of an integrated plan; and
- The cost analysis based on additional conceptual design details.

This will, in turn, support parallel organizational discussions regarding cost- and gain-sharing and the terms of a long-term institutional framework. At the conclusion of the conceptual design phase, both parties should have sufficient decision support to consider moving forward with detailed design and construction.

TRWD and the City of Dallas may, based upon the recommendations of this study, decide to further pursue joint interconnected raw water conveyance from Cedar Creek Reservoir, Richland–Chambers Reservoir and Lake Palestine. Despite a compressed timeframe for project development, careful additional study of the various issues mentioned above is recommended.

A conceptual design phase is recommended that would be jointly funded under an existing agreement between the City of Dallas and TRWD. Additional definition of infrastructure requirements at a conceptual level and further operational analysis will provide more detailed cost information. This report is a first step toward determining the viability of integrated water supply and transmission. The general OBJECTIVES of this planning and conceptual design process are:

1. Provide additional technical information to support the City of Dallas and TRWD and its primary wholesale customers with understanding project benefits and manage institutional and financial consequences;

2. Continue to advance project planning and development prior to detailed design to accommodate a 2015 delivery date;

3. Mitigate project cost and schedule variance; and

4. Ensure that the principles of the National Environmental Policy Act (NEPA) are considered early in the planning process to expedite all regulatory decisions, permitting and land acquisition.

Five **TASKS** have been identified to meet these objectives and will provide additional technical, operational, water quality, financial and contractual guidance to support decision making and project delivery. This information is needed so that that the City of Dallas, TRWD and its primary wholesale customers can make clear decisions regarding project costs, schedule, operations, and financing in support of a 2015 water delivery date:

1. Conceptual Design and Project Cost Analysis;

2. Environmental and Permitting Assessment (following NEPA principles);

3. Organizational and Financial Assessment;

4. Project Delivery, Schedule and Cost Management Plan; and

5. Delivery to DWU Water Treatment System.

Tarrant Regional Water District/ City of Dallas

SUMMARY REPORT

Project Viability Assessment and Business Case Evaluation of Raw Water Transmission System Integration

July, 2008

CDM/KBR

In Association with: R.W. Beck, KStrategies, TRC/Brandes, Espey Consultants, Inc., Patrick, Miller & Kropf, P.C., Crespo Consulting Services, Inc.

TARRANT REGIONAL WATER DISTRICT / CITY OF DALLAS

SUMMARY REPORT

PROJECT VIABILITY ASSESSMENT AND BUSINESS CASE EVALUATION OF RAW WATER TRANSMISSION SYSTEM INTEGRATION

July, 2008

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Crespo Consulting Services, Inc.

Contents

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Executive Summary

The Tarrant Regional Water District (TRWD) and the City of Dallas Water Utilities (DWU) have developed a comprehensive list of new water management strategy recommendations that include connecting Lake Palestine to the DWU water system; completion of the TRWD constructed wetlands, and construction of TRWD's Third East Texas Pipeline from Cedar Creek and Richland-Chambers Reservoirs in approximately 2015. The geographic proximity of Lake Palestine to the existing TRWD water supplies and raw water transmission facilities at Cedar Creek and Richland-Chambers Reservoirs (as shown in **Figure ES-1**) and the similarity between the proposed implementation of these water supply strategies prompted DWU and TRWD to begin preliminary discussions about an opportunity to explore an integrated approach to bring additional water into the Dallas and Tarrant Regional Water District service areas.

The purpose of this initial Project Viability Assessment and Business Case Evaluation was to 1) identify any "fatal flaws" to developing an integrated raw water transmission system; and 2) compare the separate, independently adopted water strategies of both TRWD and DWU with integrated raw water delivery system alternatives in terms of their life-cycle cost implications, water quality and treatment implications, and permitting and environmental issues. In other words, this study compared the current water supply plans of each agency with integrated raw water transmission system alternatives.

Six tasks were completed as part of this initial Project Viability Assessment and Business Case Evaluation.

1. Integrated system operations analysis;
2. Capital and life-cycle cost analysis;
3. Facility siting constraints assessment;
4. Environmental water quality review;
5. Consideration of water treatment impacts; and
6. Permitting and regulatory review.

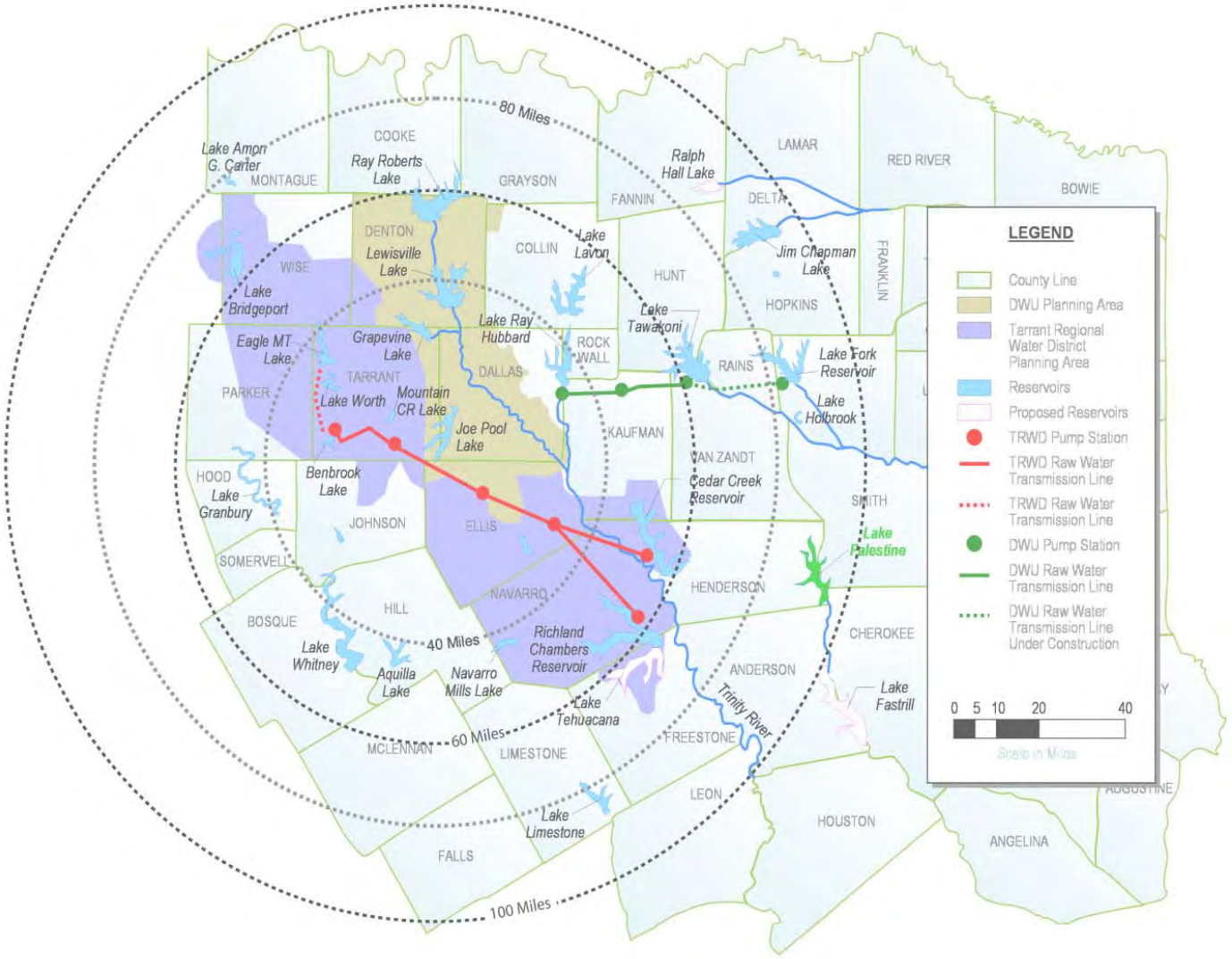

Figure ES-1
Vicinity Map

Several key objectives must be met to make a successful Business Case Evaluation that an integrated system could complement or replace existing, independent water supply plans:

- An integrated raw water transmission system alternative must enhance the redundancy, flexibility, and demand risk management of the existing water supply systems;
- An interconnected plan must make sufficient water supply available to meet demands where and when needed, under a full range of historical hydrological conditions;
- An integrated raw water transmission system alternative must reduce capital and life-cycle costs, while not contributing to unmitigated treatment or distribution costs for DWU or TRWD customers; and
- All scenarios must fully consider societal, environmental, and regulatory complexities

With these key objectives guiding the way, four project conveyance alternatives were developed through a progressive screening approach to evaluate combinations of conveyance infrastructure and interconnections, and by then selecting two Baseline Alternatives (independent water strategies) and the two most promising Interconnection Alternatives (integrated delivery systems), as described in **Table ES-1**. Additional treatment and water transmission facilities for DWU that may be required for an integrated strategy but were beyond the study boundary were also considered in this analysis (see Section 7). **Figure ES-2** maps all pipeline routes used in these project alternatives.

Table ES-1
Project Conveyance Alternatives

Alternative	Description
1 (Baseline)	**Independent Systems**: TRWD's East Texas Third Pipeline and DWU's connection of Lake Palestine to the proposed Southeast Water Treatment Plant
2 (Baseline)	**Independent Systems**: TRWD's East Texas Third Pipeline and DWU's connection of Lake Palestine to Joe Pool Lake
3 (Interconnection)	**Integrated System**: Interconnected Third Pipeline (upsized as compared to the baseline condition) with connection of Lake Palestine to Cedar Creek Reservoir and delivery to DWU at Joe Pool Lake and TRWD's customers through the Third Pipeline
4 (Interconnection)	**Integrated System**: Interconnected "Southern Pipeline" - Lake Palestine delivered to the Lake Benbrook pipeline via a pipeline route to the south of the TRWD Third Pipeline route. Delivery to DWU at Joe Pool Lake and TRWD's customers through connections to the existing system and the Lake Benbrook pipeline.

Conveyance Alternative 4 (Interconnected Southern Pipeline)

EAGLE MOUNTAIN LAKE
Eagle Mountain WTP
LAKE WORTH
Northwest WTP
Holly WTP
Pierce-Burch WTP
Electric Handley SES
LAKE ARLINGTON
Rolling Hills WTP
Arlington JFK WTP
BENBROOK LAKE
Mansfield WTP
TRA WTP
Bachman WTP
Dallas--Fort Worth--Arlington
LAKE RAY HUBBARD
Eastside WTP
SE WTP
Wax/Rocket WTP
LAKE TAWAKONI
LAKE FORK RESERVOIR
CEDAR CREEK RESERVOIR
LAKE PALESTINE
RICHLAND-CHAMBERS RESERVOIR
Interconnected Southern Pipeline (Alt 4)

Legend
- DWU PumpStations
- TRWD PumpStations
- WTP Locations
- TRWD Lakes
- Lake Palestine
- DWU Lakes
- Interconnected Southern Pipeline

1 inch equals 50,000 feet

Alternative	Description	Diameter (inches)	Length (miles)	Design Flow (with Peaking) (mgd)
4	Southern Pipeline		148	
	Palestine to CC/RC Connections	72	47	128
	CC/RC Connections to Benbrook Pipeline	108	70	331
	CC Connection to Southern Pipeline	72	8	127
	RC Connection to Southern Pipeline	66	8	76
	Southern Pipeline Connection to Joe Pool	108	16	331

CDM/KBR

Figure ES-2

Preliminary Findings

Based on the findings of this Project Viability Assessment, **Table ES-2** lists the potential advantages available to both DWU and TRWD if Lake Palestine is delivered through Interconnection Alternatives 3 or 4. The table also provides some explanation of these advantages or disadvantages.

Table ES-2
Preliminary Findings

Potential Interconnection Advantages	Benefit to DWU	Benefit to TRWD	Notes
Reduced Operating Costs	✓	✓	Operating costs within bounded system are lower in interconnected alternatives as compared to baseline alternatives. Savings more pronounced in near term and decrease over time. Near-term savings attributable to full Lake Palestine supply not being required immediately.
Water Sharing, Timing, Phasing	✓	✓	Even under drought conditions in 2020, ~80 additional mgd could be available. Portion of Lake Palestine supply required before 2020 (if DWU demand reaches 102 mgd) but could be phased through 2030. TRWD requires new water supply (above constructed wetlands) between 2030 and 2040. TRWD can sell or trade water and DWU can defer costs. Water sharing possible between both entities in short term, and in long-term during emergency situation or localized drought condition.
Demand Risk Management	✓	✓	Sharing water between the two water providers can help mitigate effects of unforeseen demand growth patterns in the TRWD or DWU systems.
Water Availability	✓	✓	Supply is limited by the permitted amounts, not water availability. During normal hydrologic periods, extra supply is available through 2060 in an interconnected system. Opportunity for both groups to benefit from this water.
Redundancy	✓	✓	Water supplier can select from multiple supply sources in times of emergency, drought, failure, etc. Opportunity for supply and failure risk management. More alternative flow pathways and connections to multiple water and power sources. Impacts of climatic variations are lessened because of diversification of reservoir locations (an interconnected system "casts a wider net").

Potential Interconnection Advantages	Benefit to DWU	Benefit to TRWD	Notes
Operational Flexibility	✓	✓	Multiple flow pathways could be used to transport water. Capitalize on advantageous opportunities for blending of sources, pump cycling schedules, system maintenance and energy management. Potential disadvantage is potential for increased operational complexity Ability to overdraft supply sources provides flexibility to system operations, the potential for lower operating costs, and risk mitigation
Regional Cooperation	✓	✓	Groundwork for interconnecting future water supply sources (Toledo Bend, Oklahoma, etc.), increasing portfolio of water supply options, reducing costs of right-of-way through earlier acquisition, providing financing risk management, facilitation of future interlocal agreements, and compliance with TWDB planning guidelines
Reduction in Life-cycle Costs	✓	✓	[1]Alternative 3 vs. 2: $537,954,000 Savings Alternative 4 vs. 2: $36,644,000 Savings
Reduction in Capital Costs	✓	✓	Alternative 3 vs. 2: $219,394,000 Savings Alternative 4 vs. 2: –$51,919,000
Environmental Water Quality	—	—	A moderate impact related to higher nutrient concentrations from Palestine will not likely affect the designated uses of the receiving reservoirs
Water Treatment Impact	—	—	Low to moderate impact on water treatment at existing and proposed WTP's. Primary impacts relate to Palestine's low alkalinity, high TOC, and high manganese concentrations
Environmental Impacts / Siting Constraints	—	—	No fatal flaws in pipeline corridors, all are potentially viable and can be recommended for further analysis. No significant differentiators between project alternatives in terms of land use, environmental, or technical (engineering) constraints
Permitting and Regulatory Issues	—	—	No fatal flaws.

[1] Interconnected Alternatives 3 and 4 deliver water to Joe Pool Lake. Baseline Alternative 2 also delivers to Joe Pool Lake but Baseline Alternative 1 delivers to the Southeast WTP. Comparisons were therefore made to Baseline Alternative 2 in this summary table because it is the most apt comparison. In subsequent report sections, comparisons with Alternative 1 are provided.

Recommendations

Based on the findings of the Business Case Evaluation in this study, **Table ES-3** summarizes a comparison of positive or negative impacts of interconnection alternatives vs. baseline plans in a Triple Bottom Line Matrix.

Table ES-3
Triple Bottom Line Matrix
Comparison of Interconnection and Baseline Alternatives

Project Element	Economic	Environmental	Social
Capital Costs	+		
Life-cycle Cost	+		+
Water Treatment Implications	–		
Permitting/Constraints	+	–	
Environmental Water Quality		–	
Water Sharing and Timing, Redundancy, Flexibility	+	+	
Regional Cooperation and Future Water Supply	+	+	+
Ellis County Service			+

This study concludes that interconnecting Lake Palestine through the TRWD system is viable – no fatal flaws have been detected in this study – and that the business case is sufficiently strong to recommend proceeding with more detailed study.

Phase II Analysis

The purpose of this study was to compare separate, independently adopted water strategies with integrated raw water delivery system alternatives, and not to select a preferred integration alternative. Though conceptual engineering and operational scenarios were studied in this effort, further analysis is needed to select a preferred integration alternative and to more fully develop how such a joint project would be planned, designed and operated to optimize economic and operational benefits to both systems. This subsequent effort must be initiated quickly due to impending supply constraints and is paramount to support development of institutional agreements and a financing strategy that will be required. It is

recommended that TRWD and the City of Dallas proceed to a Conceptual Design Phase (see Section 9 for additional detail), the purpose of which is to further develop:

- The conveyance alternatives (with more detailed hydraulic and operational analysis);
- The phasing potential of an integrated plan; and
- The cost analysis based on additional conceptual design details.

This will, in turn, support parallel organizational discussions regarding cost- and gain-sharing and the terms of a long-term institutional framework. At the conclusion of the conceptual design phase, both parties should have sufficient decision support to consider moving forward with detailed final design and construction of an interconnected raw water transmission system or independent water supply alternatives.

Data and Limitations

A short list of some of the primary project assumptions and limitations are shown below. Also, some of the key project data are summarized in **Table ES-4** to facilitate the reader's understanding of the size and scope of potential infrastructure.

- All scenarios for independent and joint water management were predicated on the assumption that DWU will utilize the full contractual yield from Lake Palestine (102 mgd) in all future years. This assumption was held constant even if some of the 102 mgd could originate from TRWD water sources in an interconnected system. This assumption was adopted for comparative purposes, and to limit the number of potential scenarios in this fatal flaw analysis by bracketing the results with limits that will not be exceeded when additional detail is added to subsequent analyses.
- This analysis used cost information and methods established in guidelines published by the Texas Water Development Board (TWDB) for use in regional water planning activities. Therefore, cost opinions were screening- or feasibility-level estimates. Unit costs were from 2006 estimates and were inflated to 1st quarter 2008 dollars. Water treatment costs are based on 2008 cost opinions.
- The water quality analysis was based on a mass balance to analyze broad impacts of blending water from Lake Palestine with the different receiving reservoirs.

Table ES-4
Information on Potential Infrastructure

Alternative	Description	Diameter (inches)	Length (miles)	Design Flow (with Peaking) (mgd)
1	Lake Pal to SE WTP	84	88	184
2	Lake Pal to Joe Pool Lake	84	105	184
1 and 2	Baseline Third Pipeline		103	
	Cedar Creek to Ennis PS	72	26	127
	Richland Cambers to Ennis PS	60	30	76
	Ennis PS to Kennedale Bal Res	84	42	203
	Kennedale Bal Res to RHWTP	96	6	203
3	Interconnected Third Pipeline		139	
	Lake Palestine to Cedar Creek	72	35	128
	Cedar Creek to Ennis PS	96	26	255
	Richland Cambers to Ennis PS	60	30	76
	Ennis PS to RH WTP	108	42	331
	Bal Res to RHWTP	126	6	331
4	Southern Pipeline		148	
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	CC/RC Connections to Benbrook Pipeline	108	70	331
	CC Connection to Southern Pipeline	72	8	127
	RC Connection to Southern Pipeline	66	8	76
	Southern Pipeline Connection to Joe Pool	108	16	331

Section 1
Introduction

1.1 Project Background

The Tarrant Regional Water District (TRWD) and the City of Dallas Water Utilities (DWU) own or hold water rights or contracts for a combined 14 surface water reservoirs and provide raw water transmission facilities for many cities and water agencies across North Central Texas. Dallas supplies treated and raw water to wholesale customers in Dallas, Collin, Denton, Ellis, and Kaufman Counties. TRWD supplies raw water and transmission services to Tarrant and 8 other counties in Region C and Johnson County in the Brazos G Region. Through 58 wholesale water agencies and cities and the DWU retail water operations, TRWD and DWU provide drinking water to 4.4 million people, a population that is expected to double in the next 50 years.

DWU has water rights for connected and unconnected surface water supplies totaling 1.8 million acre-feet per year or 1,618 million gallons per day (mgd). According to the *Long Range Water Supply Plan 2005 Update,* the actual average daily firm yield projected for 2060 is much less at 582.4 mgd (average daily). According to guidance in the Texas Water Development Board's *Exhibit B – Guidelines for Regional Water Plan Development,* "Firm yield is defined as the maximum amount of water a reservoir can provide each year during a drought of record using reasonable sedimentation rates and reasonable predetermined withdrawal patterns, assuming full utilization of upstream and downstream senior water rights and full satisfaction of environmental flow requirements and bay and estuary requirements if they apply." In general, the drought of record for North Central Texas reservoirs occurred during the drought of the 1950's.

Current population projections and water demand trends as developed in the Region C Water Plan and the 2005 Update of the Dallas Long Range Water Supply, as illustrated in **Figures 1-1a** and **1-1b**, have resulted in a comprehensive list of new water management strategy recommendations which include connecting Lake Palestine to the DWU water system, completion of the TRWD constructed wetlands, and construction of TRWD's Third East Texas Pipeline from Cedar Creek and Richland-Chambers Reservoirs in approximately 2015.

The geographic proximity of Lake Palestine to the existing TRWD water supplies and raw water transmission facilities at Cedar Creek and Richland-Chambers Reservoirs (as shown in **Figure 1-2**) and the similarity between the proposed implementation of these water supply strategies prompted DWU and TRWD to begin preliminary discussions about an opportunity to explore the conceptual feasibility of an integrated approach to bring additional water into the Dallas and Tarrant Regional Water District service areas.

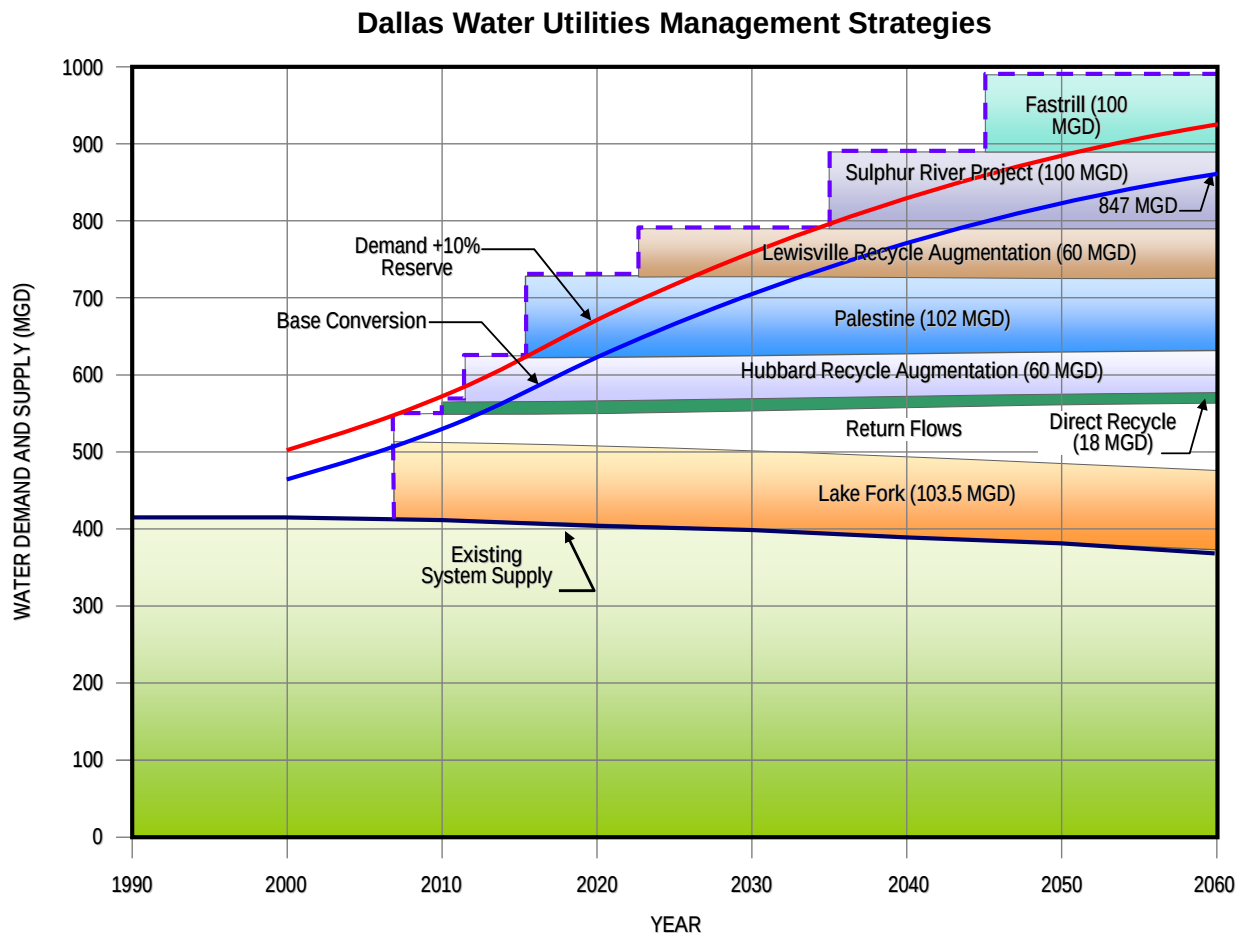


Figure 1-1a
DWU Water Management Strategies
(Figure from December 6, 2006 City Council Briefing)

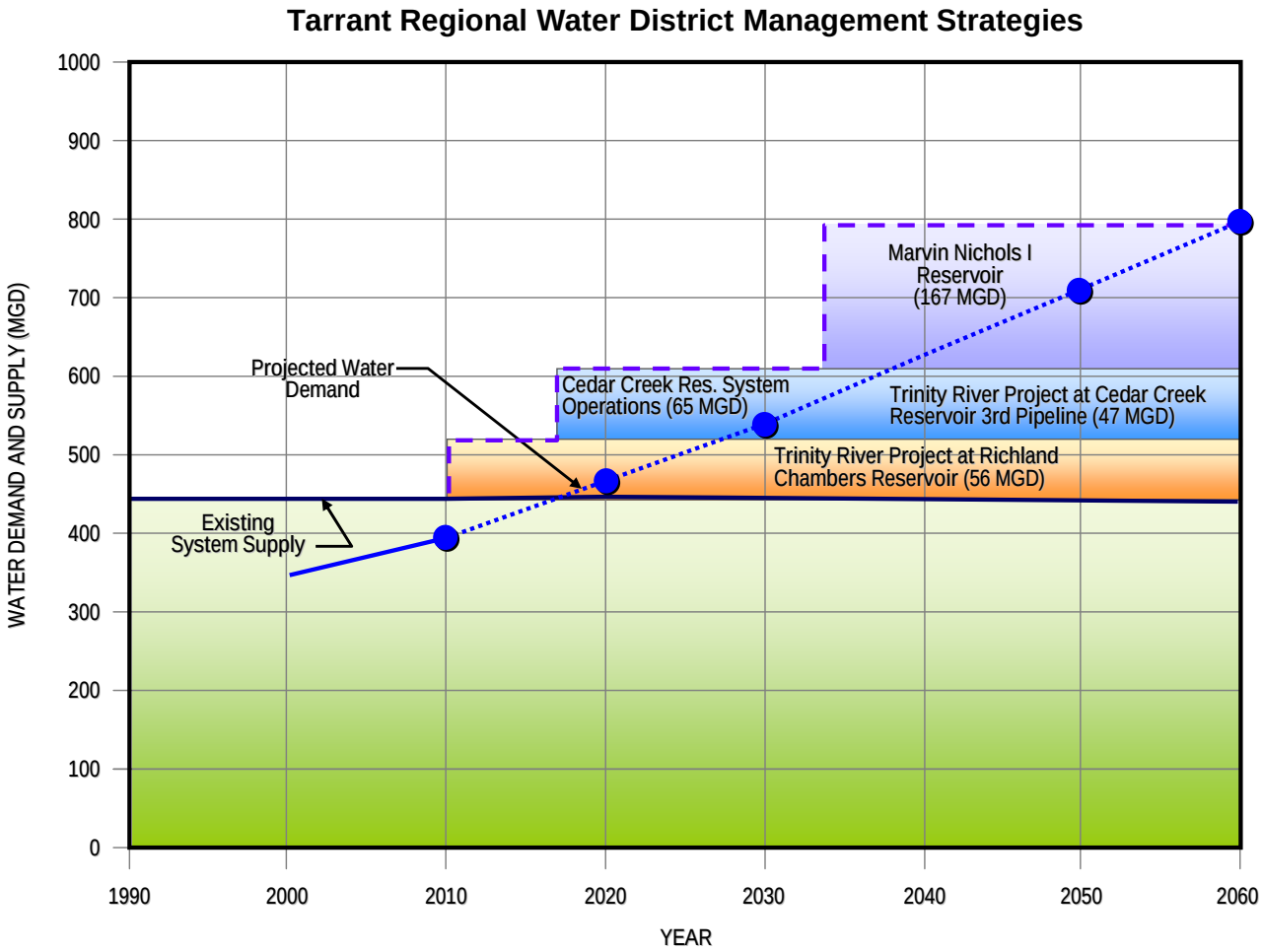


Figure 1-1b
TRWD Water Management Strategies

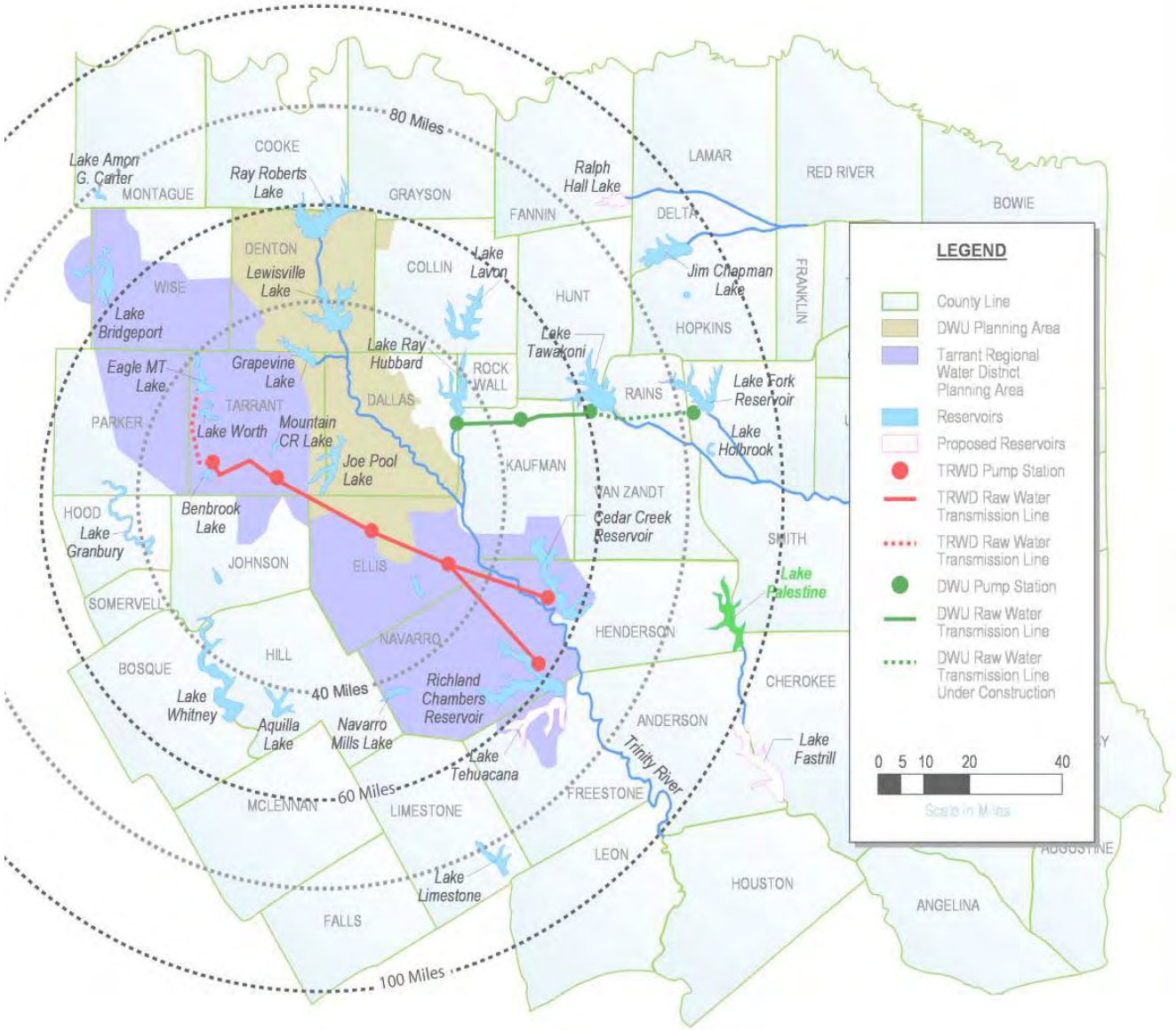


Figure 1-2
Vicinity Map

TRWD and DWU have a long history of cooperation in water supply planning, including the Texas Water Development Board regional water planning efforts initiated by the 1997 passage of Senate Bill 1 in the 75th session of the Texas Legislature. Implementation of Senate Bill 1 led to the creation of 16 regional water planning groups and the development of regional water plans that are updated every five years. The latest adopted regional water plans occurred in 2006 which led to the adoption of the 2007 State Water Plan. This study is intended to complement these ongoing regional plan updates by providing a focused initial project viability assessment and business case evaluation of integrating the TRWD and DWU raw water transmission systems, **Figure 1-2**.

1.2 Project Scope and Purpose

The purpose of this initial Project Viability Assessment and Business Case Evaluation was to 1) identify any "fatal flaws" to developing an integrated raw water transmission system; and 2) compare the separate, independently adopted water strategies of both TRWD and DWU with integrated raw water delivery system alternatives in terms of their life-cycle cost implications, water quality and treatment implications, and permitting and environmental issues. In other words, this study compared the current water supply plans of each agency with integrated raw water transmission system alternatives.

Six tasks were completed as part of this initial Project Viability Assessment and Business Case Evaluation.

1. Integrated system operations analysis;
2. Capital and life-cycle cost analysis;
3. Facility siting constraints assessment;
4. Environmental water quality review;
5. Consideration of water treatment impacts; and
6. Permitting and regulatory review.

Because of their overlapping and correlated purposes, the initial Project Viability Assessment and Business Case Evaluation are not separated in this report though the focus of each was slightly different. The purpose of the preliminary Project Viability Assessment was to identify any potential "fatal flaw" to developing an integrated system using the six tasks listed above; a fatal flaw is defined as a condition that would by itself, or when combined with other constraints, present an unavoidable obstacle that would not allow the project to proceed. The purpose of the Business Case Evaluation was to compare the separate, independently adopted water strategies of both TRWD and DWU with integrated raw water delivery system configurations using a Triple Bottom Line approach that compares the economic, environmental, and social impacts.

Several key objectives must be met to complement or replace existing, independent water supply plans:

- An integrated raw water transmission system alternative must enhance the redundancy, flexibility, and demand risk management of the existing water supply systems;
- An interconnected plan must make sufficient water supply available to meet demands where and when needed, under a full range of historical hydrological conditions;
- An integrated raw water transmission system alternative must reduce capital and life-cycle costs, while not contributing to unmitigated treatment or distribution costs for DWU or TRWD customers; and
- All scenarios must fully consider societal, environmental, and regulatory complexities

With these key objectives guiding the way, four project conveyance alternatives were developed by bounding the study (**Figure 1-3**), using a progressive screening approach to evaluate combinations of conveyance infrastructure and interconnections, and then selecting two Baseline Alternatives (independent water strategies) and the two most promising Interconnection Alternatives (integrated delivery systems), as described in **Table 1-1**. The two Baseline Alternatives represent two strategies in consideration by DWU as an independent supply option; both alternatives deliver water from Lake Palestine but differ in the delivery point (Joe Pool Lake or the Southeast Water Treatment Plant). TRWD may consider constructing a "southern pipeline" route from East Texas to Lake Benbrook as an alternative independent supply option to the Third Pipeline but this possibility was not included as a third Baseline Alternative in this analysis.

Additional treatment and water transmission facilities for DWU that may be required for an integrated strategy but were beyond the study boundary (**Figure 1-3**) are considered in Section 8 of this report. **Figure 1-4** through **Figure 1-7** illustrate the four project conveyance alternatives and **Figure 1-8** shows all pipeline routes used in these project alternatives. A description of the components in these water supply systems follows **Figure 1-8**.

Table 1-1
Project Conveyance Alternatives

Alternative	Description
1 (Baseline)	Independent Systems: TRWD's East Texas Third Pipeline and DWU's connection of Lake Palestine to the proposed Southeast Water Treatment Plant
2 (Baseline)	Independent Systems: TRWD's East Texas Third Pipeline and DWU's connection of Lake Palestine to Joe Pool Lake
3 (Interconnection)	Integrated System: Interconnected Third Pipeline (upsized as compared to the baseline condition) with connection of Lake Palestine to Cedar Creek Reservoir and delivery to DWU at Joe Pool Lake and TRWD's customers through the Third Pipeline
4 (Interconnection)	Integrated System: Interconnected "Southern Pipeline" - Lake Palestine delivered to the Lake Benbrook pipeline via a pipeline route to the south of the TRWD Third Pipeline route. Delivery to DWU at Joe Pool Lake and TRWD's customers through connections to the existing system and the Lake Benbrook pipeline.

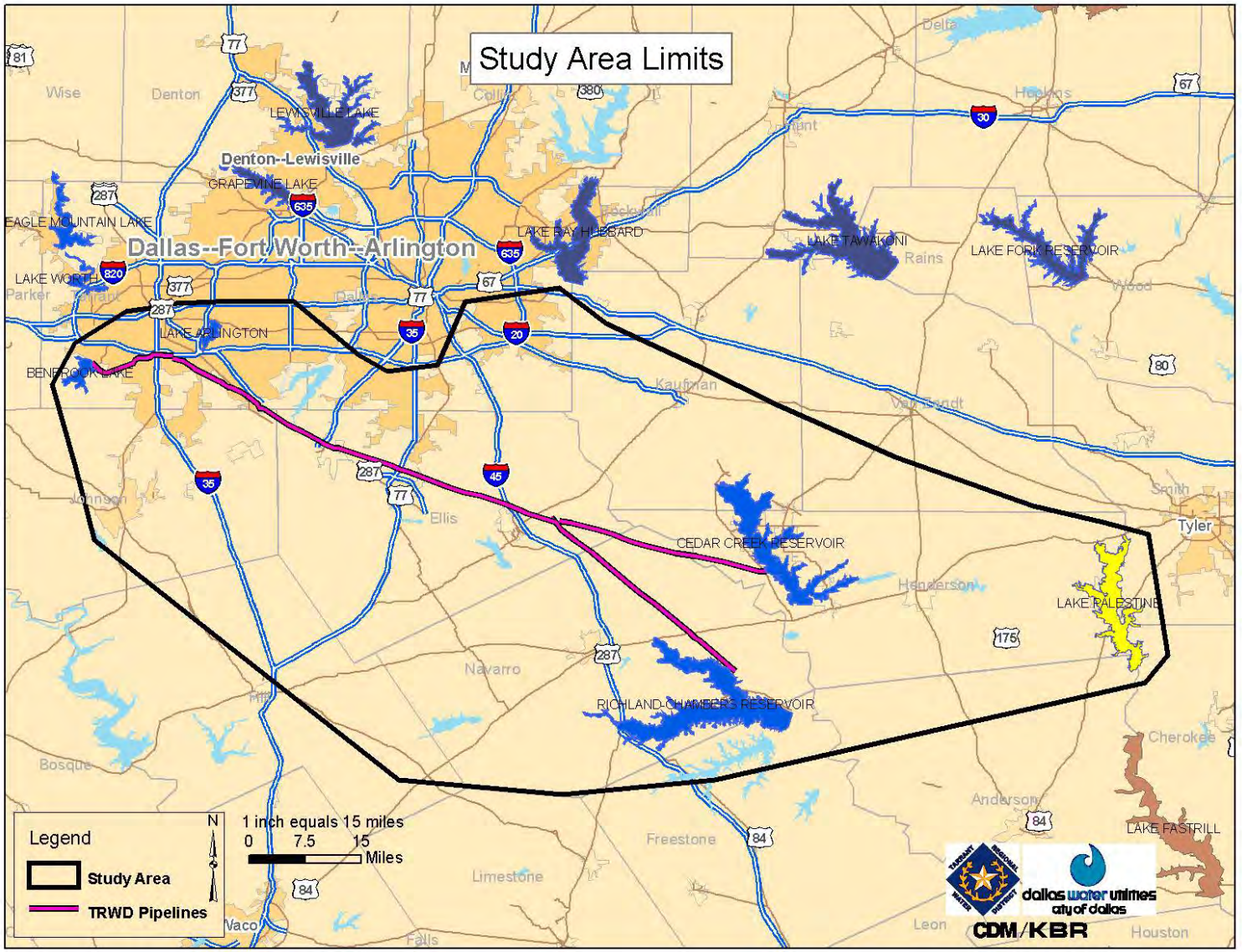
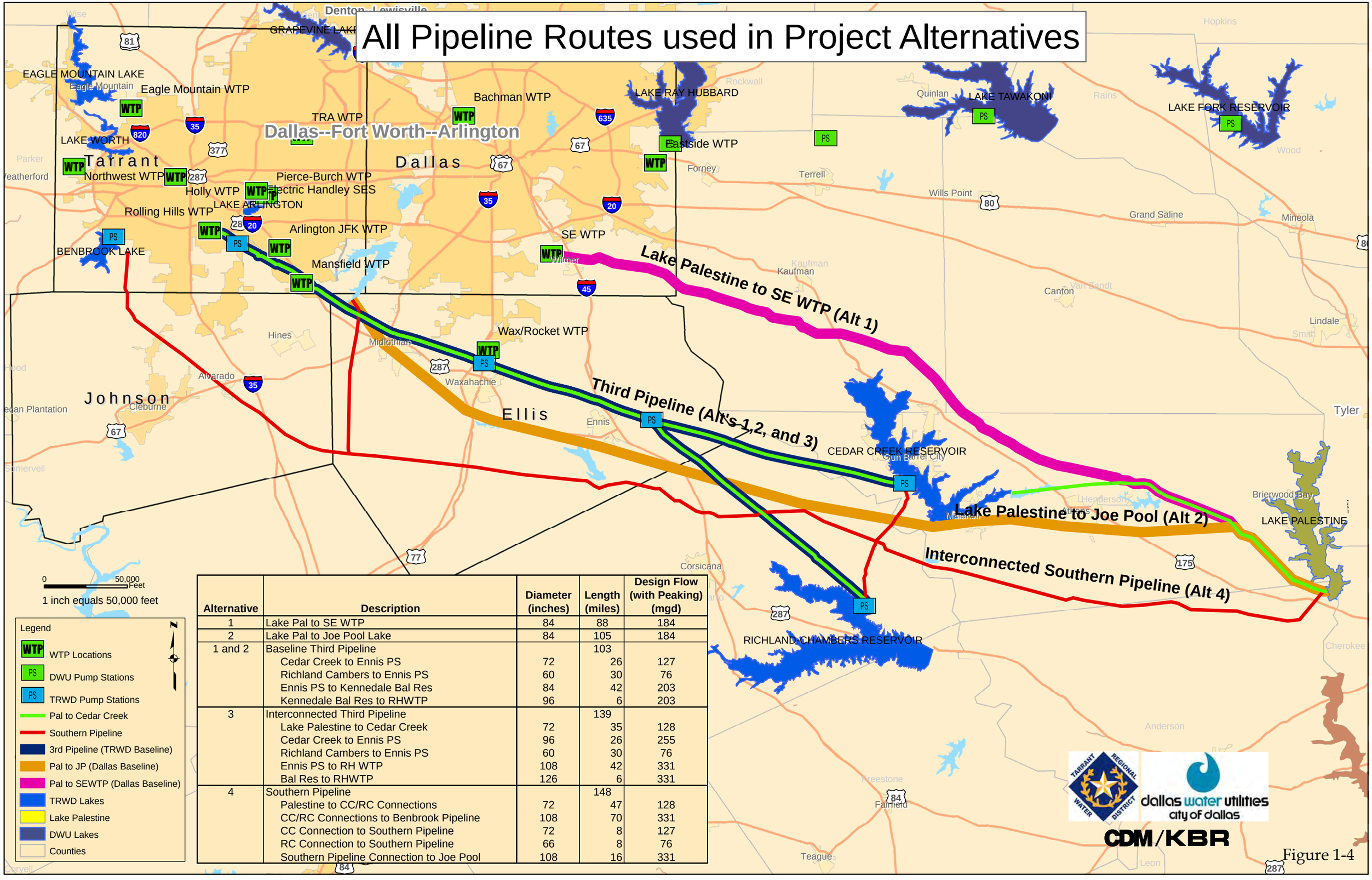


Figure 1-3
Study Area Limits

All Pipeline Routes used in Project Alternatives



0 50,000 Feet

1 inch equals 50,000 feet

Legend

- WTP Locations
- DWU Pump Stations
- TRWD Pump Stations
- Pal to Cedar Creek
- Southern Pipeline
- 3rd Pipeline (TRWD Baseline)
- Pal to JP (Dallas Baseline)
- Pal to SEWTP (Dallas Baseline)
- TRWD Lakes
- Lake Palestine
- DWU Lakes
- Counties

Alternative	Description	Diameter (inches)	Length (miles)	Design Flow (with Peaking) (mgd)
1	Lake Pal to SE WTP	84	88	184
2	Lake Pal to Joe Pool Lake	84	105	184
1 and 2	Baseline Third Pipeline		103	
	Cedar Creek to Ennis PS	72	26	127
	Richland Cambers to Ennis PS	60	30	76
	Ennis PS to Kennedale Bal Res	84	42	203
	Kennedale Bal Res to RHWTP	96	6	203
3	Interconnected Third Pipeline		139	
	Lake Palestine to Cedar Creek	72	35	128
	Cedar Creek to Ennis PS	96	26	255
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	Ennis PS to RH WTP	108	42	331
	Bal Res to RHWTP	126	6	331
4	Southern Pipeline		148	
	Palestine to CC/RC Connections	72	47	128
	CC/RC Connections to Benbrook Pipeline	108	70	331
	CC Connection to Southern Pipeline	72	8	127
	RC Connection to Southern Pipeline	66	8	76
	Southern Pipeline Connection to Joe Pool	108	16	331

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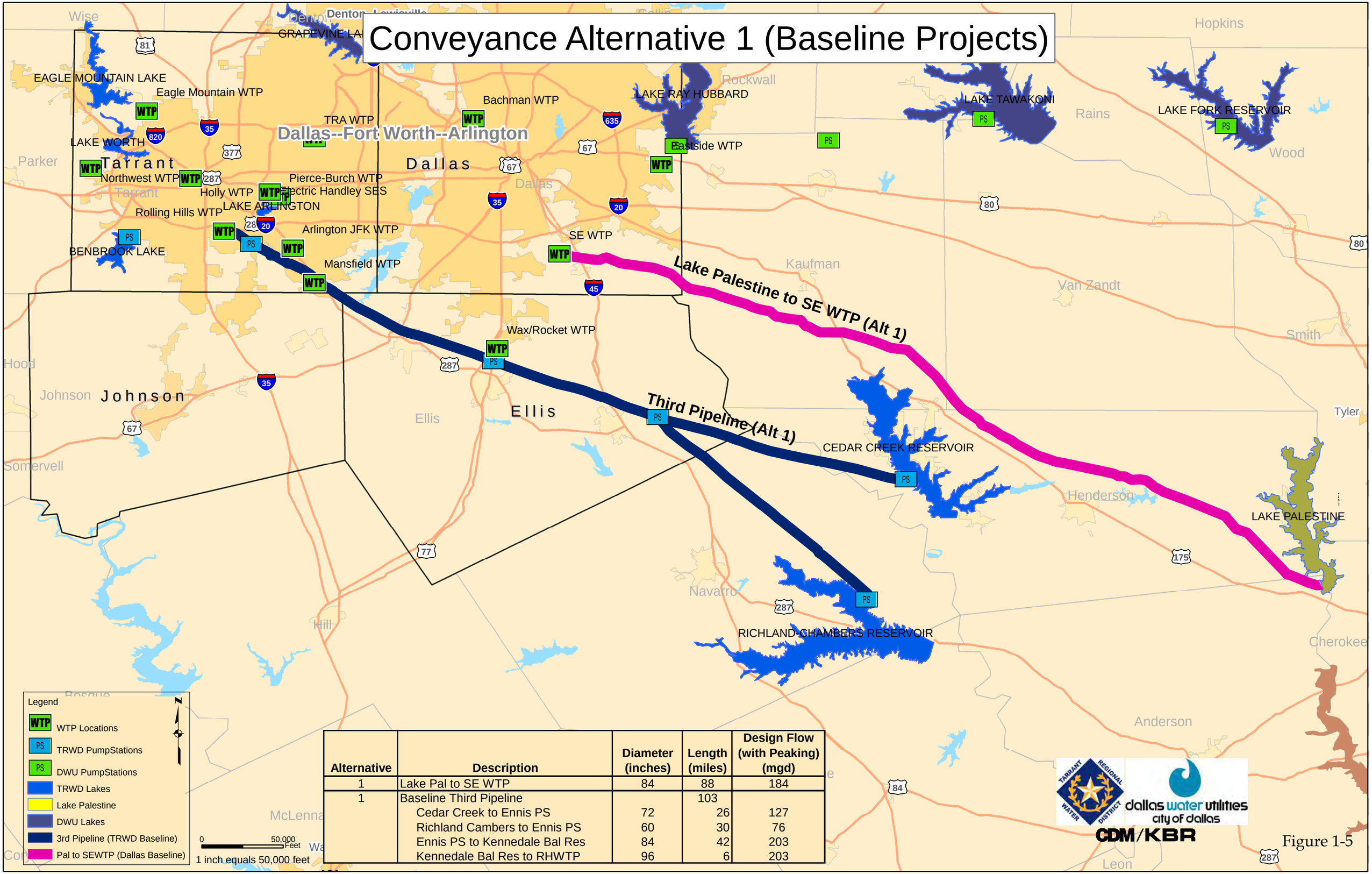
Figure 1-4

Conveyance Alternative 1 (Baseline Projects)



Legend

- WTP Locations
- TRWD PumpStations
- DWU PumpStations
- TRWD Lakes
- Lake Palestine
- DWU Lakes
- 3rd Pipeline (TRWD Baseline)
- Pal to SEWTP (Dallas Baseline)

0 50,000 Feet

1 inch equals 50,000 feet

Alternative	Description	Diameter (inches)	Length (miles)	Design Flow (with Peaking) (mgd)
1	Lake Pal to SE WTP	84	88	184
1	Baseline Third Pipeline		103	
	Cedar Creek to Ennis PS	72	26	127
	Richland Cambers to Ennis PS	60	30	76
	Ennis PS to Kennedale Bal Res	84	42	203
	Kennedale Bal Res to RHWTP	96	6	203

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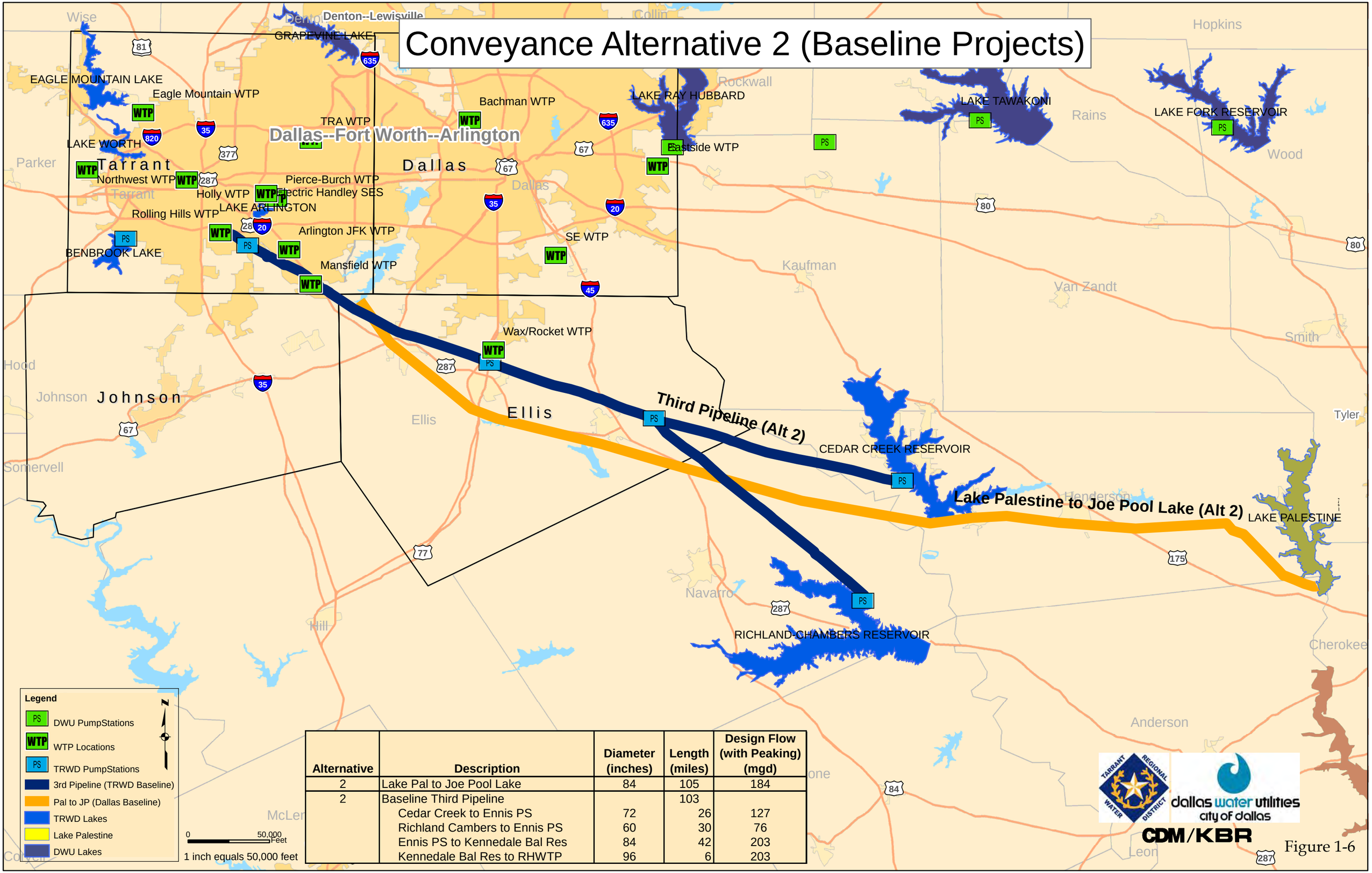
Figure 1-5

Conveyance Alternative 2 (Baseline Projects)



Legend

- PS — DWU PumpStations
- WTP — WTP Locations
- PS — TRWD PumpStations
- 3rd Pipeline (TRWD Baseline)
- Pal to JP (Dallas Baseline)
- TRWD Lakes
- Lake Palestine
- DWU Lakes

0 50,000 Feet

1 inch equals 50,000 feet

Alternative	Description	Diameter (inches)	Length (miles)	Design Flow (with Peaking) (mgd)
2	Lake Pal to Joe Pool Lake	84	105	184
2	Baseline Third Pipeline		103	
	Cedar Creek to Ennis PS	72	26	127
	Richland Cambers to Ennis PS	60	30	76
	Ennis PS to Kennedale Bal Res	84	42	203
	Kennedale Bal Res to RHWTP	96	6	203

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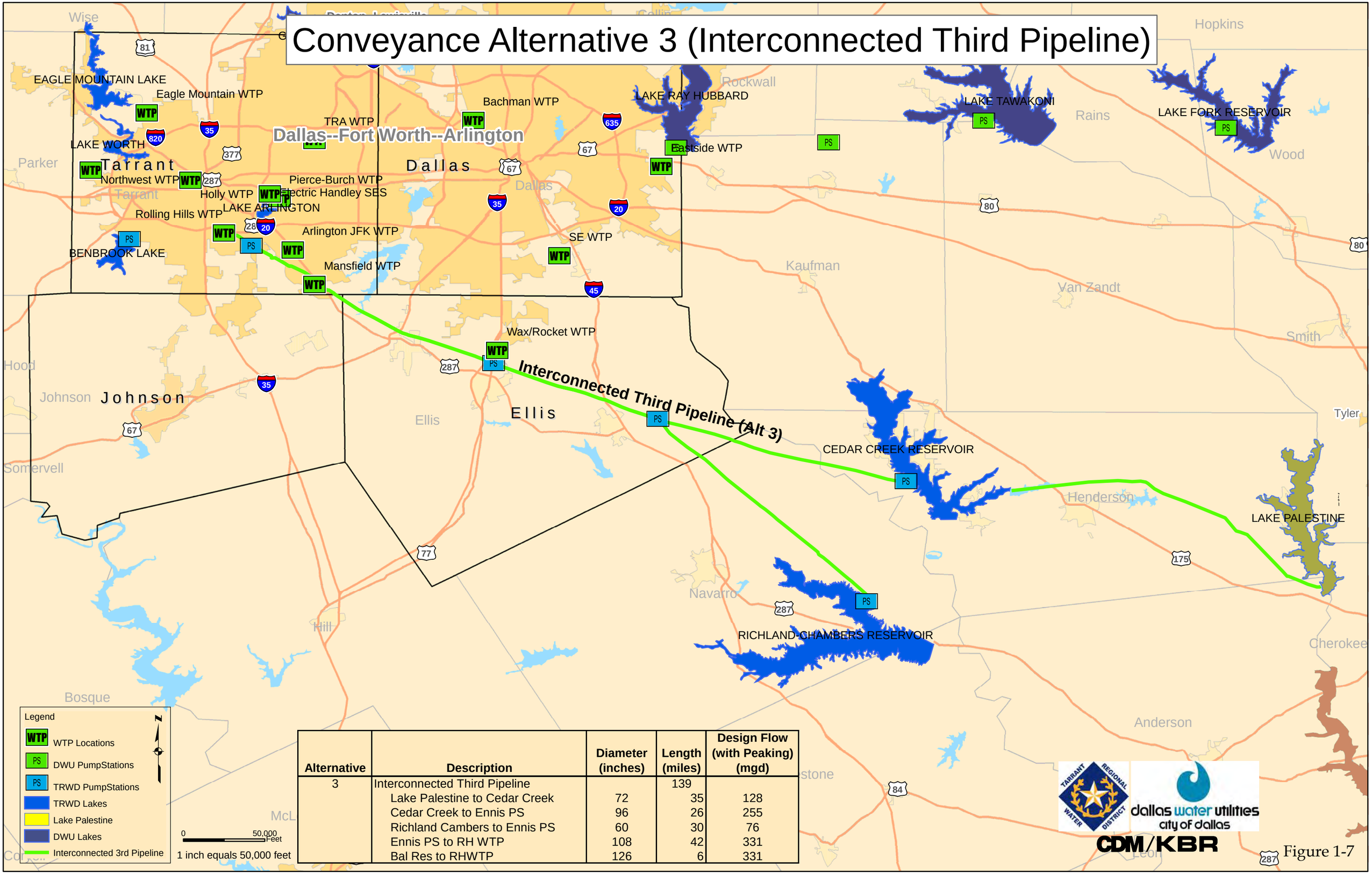
Figure 1-6

Conveyance Alternative 3 (Interconnected Third Pipeline)



Legend

- WTP — WTP Locations
- PS — DWU PumpStations
- PS — TRWD PumpStations
- TRWD Lakes
- Lake Palestine
- DWU Lakes
- Interconnected 3rd Pipeline

N

0 50,000 Feet

1 inch equals 50,000 feet

Alternative	Description	Diameter (inches)	Length (miles)	Design Flow (with Peaking) (mgd)
3	Interconnected Third Pipeline		139	
	Lake Palestine to Cedar Creek	72	35	128
	Cedar Creek to Ennis PS	96	26	255
	Richland Cambers to Ennis PS	60	30	76
	Ennis PS to RH WTP	108	42	331
	Bal Res to RHWTP	126	6	331

Tarrant Regional Water District

dallas water utilities
city of dallas

CDM/KBR

Figure 1-7

Conveyance Alternative 4 (Interconnected Southern Pipeline)

Interconnected Southern Pipeline (Alt 4)

Alternative	Description	Diameter (inches)	Length (miles)	Design Flow (with Peaking) (mgd)
4	Southern Pipeline		148	
	Palestine to CC/RC Connections	72	47	128
	CC/RC Connections to Benbrook Pipeline	108	70	331
	CC Connection to Southern Pipeline	72	8	127
	RC Connection to Southern Pipeline	66	8	76
	Southern Pipeline Connection to Joe Pool	108	16	331

Legend
- PS — DWU PumpStations
- PS — TRWD PumpStations
- WTP — WTP Locations
- TRWD Lakes
- Lake Palestine
- DWU Lakes
- Interconnected Southern Pipeline

0 50,000 Feet
1 inch equals 50,000 feet

CDM/KBR

Figure 1-8

1.3 System Descriptions

1.3.1 Lake Palestine

Lake Palestine is owned and operated by the Upper Neches River Municipal Water Authority (UNRMWA) and is located in Region I (East Texas Region) approximately 85 miles southeast of Dallas. UNMWA has contracted to supply up to 114,937 acre-feet per year, (average 102 million gallons per day) to Dallas which holds an interbasin transfer permit to the Trinity River Basin. The 2006 Region C Water Plan recommends as a Water Management Strategy (WMS) that Dallas construct the infrastructure to transport this water from Lake Palestine to Dallas because of its relatively low cost and environmental and permitting risk impact.

1.3.2 Proposed Southeast Water Treatment Plant and Joe Pool Lake

The proposed DWU Raw Water Supply System for the Southeast Water Treatment Plant (SEWTP) would convey Lake Palestine and, possibly in the future, Lake Fastrill, Toledo Bend Reservoir, and other East Texas water supplies to the site purchased for the Southeast Water Treatment Plant. Updated planning level cost estimates have been developed for the raw water transmission facilities needed to transport water to this site for Dallas.

Lake Palestine Spillway

Joe Pool Lake is located on Mountain Creek in the Trinity River Basin in both Dallas and Tarrant Counties. This U.S. Army Corps of Engineers (USACE) reservoir has conservation storage of 176,900 acre-feet. The Trinity River Authority (TRA) has a water supply agreement with the Corps of Engineers and holds the water rights for 17,000 acre-feet per year, or 15 mgd average. According to the Texas Commission on Environmental Quality (TCEQ) Trinity River Water Availability Model (WAM), the available water supply from Joe Pool Lake in 2060 will be 10,000 acre-feet per year. For purposes of this investigation, conveyance alternative 2 and both interconnection alternatives deliver water to the Joe Pool Lake vicinity. Currently Joe Pool Lake serves as a public water supply for the City of Midlothian, which has a water intake structure in the southeast leg of the lake. TRA also has a water intake structure in Cedar Hill State Park, but it is not currently in use. Several other entities have a contractual interest in Joe Pool Lake with TRA but are not currently using it as a drinking water supply.

- City of Grand Prairie – 1,795 acre-feet per year for municipal and domestic uses.
- City of Duncanville – 1,197 acre-feet per year for municipal and domestic uses.

- Midlothian Water District – 6,662 acre-feet per year for municipal and domestic uses

- City of Cedar Hill – 7,346 acre-feet per year for municipal and domestic and industrial uses.

1.3.3 TRWD East Texas Supply

Cedar Creek Reservoir is located on Cedar Creek in the Trinity River Basin in Henderson and Kaufman Counties. The reservoir has 678,900 acre-feet of conservation storage. TRWD holds a water right for diversion of 175,000 acre-feet per year (156 mgd average). According to the TCEQ Trinity River WAM, the available safe yield (synonymous to firm yield except reservoir is left with one year of storage at the end of the critical drought as opposed to zero storage) from Cedar Creek in 2060 will be 175,000 acre-feet per year. TRWD conveys water from Cedar Creek Reservoir through an existing pipeline and will increase conveyance capacity with the proposed Third Pipeline to convey the full 175,000 acre-feet per year and an additional 52,500 acre-feet per year from the Trinity River constructed wetlands.

Richland-Chambers Reservoir is located on Richland and Chambers Creeks in the Trinity River Basin in Freestone and Navarro Counties. The reservoir has 1,135,000 acre-feet of conservation storage. TRWD and the City of Corsicana hold combined water rights in the reservoir totaling 223,650 acre-feet per year with TRWD holding 210,000 acre-feet per year (187 mgd average). According to the TCEQ Trinity River WAM results, the available safe yield from Richland-Chambers will decrease by approximately 35,300 acre-feet per year from 2010 to 2060. However, TRWD analysis has shown that sedimentation rates currently projected in the Texas regional planning models are overstated and that actual rates will have a negligible effect on the safe yield. TRWD conveys supply from Richland-Chambers Reservoir through an existing pipeline and will increase conveyance capacity with the proposed Third Pipeline to convey the full 210,000 acre-feet per year and an additional 63,000 acre-feet per year from the Trinity River constructed wetlands.

The system also includes Lake Arlington, owned by the City of Arlington and ExTx LaPorte, and Lake Benbrook owned by the Corps of Engineers with TRWD holding a contract with USACE and a TCEQ water right permit. Both of these reservoirs provide terminal storage for the District's customers with relatively small yields from upstream runoff. Lake Benbrook is located on the Clear Fork of the Trinity River in Tarrant County and has conservation storage of 72,500 acre-feet; TRWD has a maximum overdraft diversion of 72,500 acre-feet per year on a non-priority basis. Lake Arlington, also in Tarrant County, is located on Village Creek and has 45,710 acre-feet of conservation storage. These terminal storage reservoirs primarily receive waters pumped from Richland-Chambers or Cedar Creek Reservoirs.

The Tarrant Regional Water District also has received a water rights permit from the Texas Commission on Environmental Quality allowing the diversion of return flows of treated wastewater from the Trinity River. TRWD has plans to pump the return

flows from the Trinity River into constructed wetlands and then into Richland-Chambers Reservoir and Cedar Creek Reservoir. This project will provide an additional 115,500 acre-feet per year of new supply. The Region C Plan recommends this relatively inexpensive source of water and the associated raw water delivery facilities of a third pipeline as a preferred water management strategy. For purposes of this study, both the constructed wetlands at the two reservoirs and all the additional conveyance facilities to deliver the constructed wetlands water supply to Richland-Chambers and Cedar Creek Reservoirs are assumed to be complete and in use by 2020.

1.3.4 TRWD West Fork Supply

The West Fork Trinity River portion of TRWD's system includes Lake Bridgeport and Eagle Mountain Lake owned and operated by the District, and Lake Worth owned by the City of Fort Worth. Water from the West Fork of the Trinity River Basin flows by gravity from Lake Bridgeport into Eagle Mountain Lake and then on to Lake Worth. In May 2008 the District completed its Eagle Mountain Connection Project which includes pipelines, pump stations and other facilities to interconnect the District's eastern and western supplies. Through this project, water from Cedar Creek and Richland-Chambers Reservoirs is conveyed to Eagle Mountain Lake.

The volume and rate of water delivered to Eagle Mountain Lake through the Eagle Mountain Connection was included in the modeling. No detailed modeling of the West Fork supply was included in this analysis because integration of the raw water system will not affect the West Fork – it acts as an external demand or supply to the integrated system but it is not requisite to model the disaggregated West Fork supplies in this study.

1.4 Assumptions and Limitations

As described in Section 1.2, the purpose of this initial Project Viability Assessment was to identify any potential "fatal flaw" to developing an integrated system and the purpose of the Business Case Evaluation was to compare the separate, independently adopted water strategies of both TRWD and DWU with integrated raw water delivery system configurations. This is therefore a preliminary, fatal-flaw level analysis with inherent limitations and risk factors. This section captures the principle assumptions and limitations in the six project analyses.

1.4.1 Integrated Operations Analysis

To examine some of the principal differences between routing water from Lake Palestine directly to DWU's terminal points and routing it through new and existing TRWD infrastructure, an integrated system operations model was developed. The model is neither a comprehensive hydraulic model nor a prescriptive day-to-day operations model. *The results from the optimization program should not be construed as a prescriptive approach for future operations, but rather, as a simple means of bounding the theoretical performance of the conveyance alternatives.*

- Operations costs consider only the energy cost in the conveyance system. Routine operations and maintenance is not included and treatment costs are also excluded.

- No adjustments were made to apply downstream release requirements that were not explicitly included in the RiverWare model.

- This optimization model is not intended to function as a hydraulic model. It is intended to provide an understanding of basic delivery requirements necessary to identify energy needs and costs associated with moving water through the system. Calculations for head requirements (elevation and line losses) were conducted outside of the model and these relationships were imported in simplified form so that movement of water incurs costs on a relative basis throughout the system.

- All scenarios for independent and joint water management were predicated on the assumption that DWU requires the full yield from Lake Palestine (102 mgd) in all future years. This assumption was held constant even if some of the 102 mgd could originate from TRWD water sources in an interconnected system. This assumption was adopted for comparative purposes, and to limit the number of potential scenarios in this fatal flaw analysis by bracketing the results. Though other scenarios with varying DWU demand on Lake Palestine water will provide enhanced detail, the fundamental question of the potential opportunities for benefits through integration is captured with this assumption and additional detail will not create results outside of the limits imposed by this assumption.

1.4.2 Capital and Life-Cycle Cost Analysis

The purpose of the cost analysis task was to develop a screening level/conceptual opinion of probable capital and lifecycle cost for each project conveyance alternative and to conduct a present worth economic comparison between the Baseline and Interconnection alternatives. The cost analyses represent total costs for water delivery and do not allocate costs between DWU and TRWD. The capital cost opinions presented herein are based on guidelines established by the Texas Water Development Board (TWDB) for use in regional water planning activities.

These cost opinions are roughly equivalent to a screening- or feasibility-level Class 4 to Class 5 estimate (per AACEI International Recommended Practice No. 17R-97, as shown in **Figure 1-9**).

Spreadsheet cost models were developed to aid in the formulation of a conceptual opinion of probable capital cost for each project scenario. These cost models incorporate planning level engineering design assumptions and a contingency appropriate to this early phase of project definition and development and in consideration of the limited availability of site-specific data.

Capital cost estimates derived from TWDB guidelines for regional water planning include assumptions and inherent uncertainties that may introduce significant

inaccuracies into the analysis. These assumptions and uncertainties will be revisited and refined through subsequent phases of project definition and development. Key assumptions and uncertainties include:

1. The analysis does not include detailed cost engineering to determine probable material and labor costs at the time of construction, possibly five or more years into the future. Unit costs are based on updates from 2002 levels to 2006 levels, prepared by Region C for incorporation into the 2011 water plan. These 2002 cost levels are currently shown in tables in Appendix U of the 2006 Region C Water Plan. For this analysis, Engineering News Record (ENR) cost indexes and U.S. Bureau of Labor Statistics data (Producer Price Index, Material Price Index) were used to escalate the unit costs of pipelines and pump stations, the two largest cost components of each project scenario, from 2006 to 2008.

2. Costs associated with the closure, mitigation and/or relocation of oil and gas wells, environmental mitigation, relocations of existing infrastructure, and other similar design issues cannot be accurately estimated at this stage of project definition and development.

	Primary Characteristic	*Secondary Characteristic*			
ESTIMATE CLASS	LEVEL OF PROJECT DEFINITION Expressed as % of complete definition	END USAGE Typical purpose of estimate	METHODOLOGY Typical estimating method	EXPECTED ACCURACY RANGE Typical +/- range relative to best index of 1 [a]	PREPARATION EFFORT Typical degree of effort relative to least cost of index 1 [b]
Class 5	0% to 2%	Screening or Feasibility	Stochastic or Judgment	4 to 20	1
Class 4	1% to 15%	Concept Study or Feasibility	Primary Stochastic	3 to 12	2 to 4
Class 3	10% to 40%	Budget, Authorization or Control	Mixed, but Primarily Stochastic	2 to 6	3 to 10
Class 2	30% to 70%	Control or Bid/Tender	Primarily Deterministic	1 to 3	5 to 20
Class 1	50% to 100%	Check Estimate or Bid/Tender	Deterministic	1	10 to 100

Notes: [a] If the range index of value "1" represents +10/5%, then an index value of 10 represents +100/-50%
[b] if the cost index value of "1" represents 0.005% of project costs, then an index value of 100 represents 0.5%.

Figure 1-9
Association for the Advancement of Cost Engineering,
Recommended Practice 17R-97; Cost Estimating Classification System

3. Real estate acquisition costs and issues cannot be evaluated at this stage of project development and will undoubtedly impact project cost estimates. In addition to uncertainties regarding the cost of real estate acquisition, capital cost estimates for each project alternative could be impacted if real estate issues dictate transmission system alignments that are longer or are at higher elevations, or both. A more detailed analysis of alternative pipeline alignments will be performed in a subsequent phase of project development. Rates of $3,000 per acre of permanent easement and $1,500 per acre of temporary easement were used (per Region C guidelines).

4. Per direction received in Workshop 1, additional conveyance capacity to accommodate future supply sources to the east was not included in the conceptual design of these systems. Instead, it was assumed that the cost of easements will include right-of-way for pipelines in the project scenarios of this study and additional right-of-way sufficient for one additional pipeline of equal dimensions.

5. In alternatives utilizing the Third Pipeline route, it may be possible to upgrade or expand existing pump stations to accommodate additional capacity. In this analysis, these cost savings were not accounted for in an effort to be conservative.

1.4.3 Future Capital and Life-Cycle Cost Analysis

The purpose of the capital and life cycle cost analysis was to provide preliminary data to allow the sponsors, DWU and TRWD, to make an informed decision as to whether to proceed with further definition and development of a project to integrate water transmission facilities to deliver raw water from Lake Palestine and the TRWD East Texas system. Because of the high-level nature of the analysis, the capital cost estimates and lifecycle cost analyses will need to be refined and updated in subsequent phases of project definition and development. Also, additional analysis will provide more information to differentiate between interconnection alternatives and between baseline and interconnection alternatives. Recommended refinements in the cost analysis are:

- Though phasing opportunities are discussed in section 2 of this report, phasing is not addressed in the cost analyses. However, it could have significant impacts on lifecycle costs, potentially increasing the cost differential between the Baseline and Interconnection scenarios. Specifically, phasing could result in significant reduction of costs associated with the Interconnected Southern Pipeline due to the potential to defer development of transmission facilities required to deliver water to Lake Benbrook. Though phasing could be a proportionally larger benefit in terms of the life cycle costs of the Southern Pipeline, the purpose of this investigation was not to identify a preferred alternative but rather to compare Baseline and Interconnected project scenarios.

- The location of booster and intake pump stations will impact the cost of electricity inasmuch as those facilities could be served by suppliers with lower or higher rates. However, because these locations will likely change on the order of many miles, the energy provider used in this analysis (based on conceptual siting) may change in subsequent phases and updates to cost analyses should include more specific energy cost data as it becomes available.

- Refinements and updates to the capital cost modeling should occur as specific alignments are selected and as the design of facilities progresses.

- These cost analyses represent total costs for water delivery and do not attempt to allocate costs to DWU and TRWD systems. Subsequent phases in this feasibility assessment will address cost and gain sharing.

1.4.4 Constraints Analysis

A preliminary facility siting constraints analysis was performed to identify potential fatal flaws to locating water transmission facilities along select pipeline corridors and to make a comparison between project conveyance alternatives. The preliminary constraints analysis was accomplished using publicly available data from secondary sources with no field data collection. Because additional site-specific data and more detailed analysis will be required in subsequent phases to fully assess potential constraints and impacts, the "opinion of probable impact" will likely be modified as additional data is acquired and pipeline alignments are refined.

The primary components of each of the project conveyance alternatives are transmission pipelines. Though intakes and booster pump stations are also required, the location of these facilities is at a conceptual, approximate level. Because these locations will likely change on the order of many miles throughout the planning and design phases, analyzing constraints to siting pumping facilities was not appropriate at this stage and is reserved for future phases when these locations are less subject to change.

The preliminary findings of the constraints analysis are contained in the Alternatives Evaluation Matrix (AEM), with an analysis of each evaluation criterion and component, and an impact rating for each evaluation criterion. The evaluation is qualitative and will be modified and enhanced as additional data become available and as engineering analyses progress in subsequent phases of project definition and development. It should be noted that the ratings developed in this analysis do not consider several factors, although these factors will be evaluated during subsequent phases:

- Construction schedule;

- Permitting requirements;

- Political favorability;

- Land ownership (data not yet available);
- Operations and Maintenance considerations (beyond cost, which is included in the lifecycle cost analysis); and
- System compatibility and operations.

1.4.5 Environmental Water Quality and Water Treatment Considerations

The purpose of the environmental water quality review was to determine impacts on receiving water quality by the introduction of Lake Palestine water under varying conditions into Lake Benbrook, Cedar Creek Reservoir, Richland-Chambers Reservoir, and Joe Pool Lake. The water quality review included data collection and analysis, mass balance calculations, and a water quality evaluation.

Atrazine data was not available in Lake Palestine or Cedar Creek Reservoir and bromide data was not available in Joe Pool Lake. The majority of the bromide data for Lake Benbrook, Cedar Creek Reservoir, and Richland-Chambers Reservoir included reported values with numerous detection limits. The detection limits were not consistent from reservoir to reservoir and were much higher than the suspected actual concentration. Accordingly, the bromide data were not utilized as part of this environmental water quality evaluation due to the inconsistency of the testing protocols and concerns about the integrity of the available reported data.

The results of this water quality analysis were based on a mass balance of water from Lake Palestine and the receiving reservoir. While this evaluation can provide information that is useful in a planning context by analyzing the broad impacts of blending water from Lake Palestine with the different reservoirs, a more comprehensive analysis should be conducted to provide the level of detail needed for final decision making purposes. The development of hydrodynamic and water quality models would provide the level of detail needed to predict the specific impact on the receiving reservoir.

As noted in the 2006 Region C Water Plan, in general, East Texas reservoirs such as Lake Palestine have higher concentrations of nutrients than the evaluated receiving reservoirs. The ultimate impact of the imported Lake Palestine water with its higher nutrient concentrations is difficult to predict in this evaluation due to the complex kinetic relationships between nutrients and chlorophyll-a. It should be noted, however, that in the Region C Water Plan all of the water management strategies involving importation of water from East Texas were considered to have “low” or medium-low” impacts on the key water quality parameters.

Section 2
Integrated Operations

2.1 Purpose

The purpose of this analysis was to identify opportunities for benefits, or potential disadvantages, to both TRWD and DWU through integrated operations of the raw water transmission systems from Lake Palestine, Richland-Chambers Reservoir, and Cedar Creek Reservoir. This comparison of Baseline Alternatives 1 and 2 with Interconnection Alternatives 3 and 4 (see **Table 1-1**) was driven by a system operations model and the team's water resource planning experience. This model was formulated as a decision-support system that permitted the user to create an array of scenarios that help answer a series of primary and secondary questions, formulated jointly by the project participants during workshops:

Primary Questions

- Can an integrated system offer the same **supply reliability** and an opportunity to lower **operational costs**?
- Are there potential opportunities for **shared water**, and therefore demand risk management**,** in addition to shared conveyance infrastructure?
- Is there an opportunity for greater **redundancy** (and therefore cost and operational risk management) through more **flexibility** in flow pathways and connectivity to multiple sources?

Secondary Questions

- How might the integration of the two systems affect the **timing** needs for various flow pathways and source connections?
- Could **more water** be made available through an interconnected system than through two independent systems?
- What opportunities for **regional cooperation** are made possible by integrated operations?

The modeling team isolated components of the two supply systems that would be most directly affected by the two programmatic alternatives (Baseline or Interconnection) and created an array of scenarios that bounded the opportunities for benefits to both TRWD and DWU. In other words, scenarios were selected to bracket results with an upper and lower bound so that any additional refinements to this analysis will produce results that fall within the bounds identified here. Using these analyses and the team's water resources planning experience, advantages and disadvantages to interconnection were identified in terms of **operational costs** (see Section 3 for capital and lifecycle cost analyses)**, water sharing and timing,**

redundancy, flexibility, and regional cooperation. The following sections describe the modeling approach and conclusions drawn from this analysis.

2.2 Modeling Approach

A detailed modeling plan memorandum was developed in November 2007. This section is intended to provide an overview of the final modeling approach, which followed the original plan with minor adjustments, by briefly discussing tools, techniques, and guidelines. In this way, the results can be understood in their appropriate context.

To isolate components of the two supply systems that would be most directly affected by the two programmatic alternatives (Baseline or Interconnection), and to avoid unnecessary detail associated with subsystems less directly affected, the system was bounded as shown in **Figure 2-1** for modeling purposes. Because not every DWU and TRWD demand node is included in the model, total water user group demand was apportioned between model nodes in the following way:

- **DWU**: The total demand on the modeled system, at either Joe Pool Lake or the Southeast WTP, was Dallas' contracted amount from Lake Palestine, 102 mgd. This isolated the direct impacts of Dallas demand on the conveyance alternatives.

- **TRWD**: Projected demands at each node were extracted from the RiverWare model. To approximate the demand from external nodes on water within the modeled system, the TRWD RiverWare model was used to simulate the West Fork system. These external node demands are initially satisfied by water originating in the West Fork. Water from the modeled system is also delivered to Eagle Mountain Lake.

  West Fork supply is capped by a contractual limitation for normal and drought conditions applicable to the City of Fort Worth. Demand in the West Fork that is not satisfied by West Fork flows is supplied from the bounded system in the optimization model. Water to satisfy monthly targets in Lake Arlington, as well as maintaining minimum conservation pool level at Lake Benbrook; also implicitly represent an internal demand on system water.

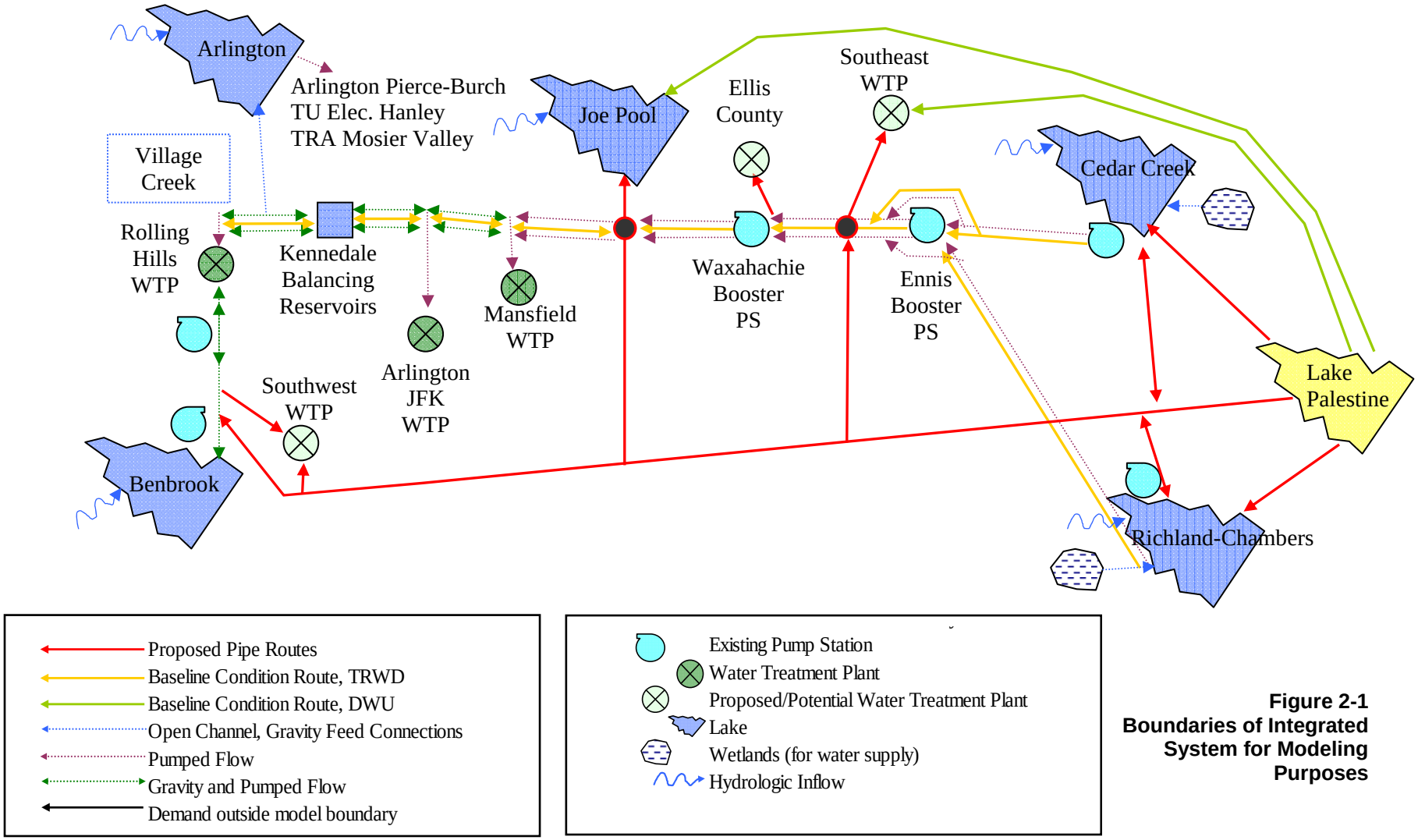


Figure 2-1
Boundaries of Integrated System for Modeling Purposes

- **Ellis County**: Projected demands for Ellis County were based on a combination of Region C 2006 Water Plan projections and the current Region C Four County Study conducted by Freese & Nichols, Inc. These demands were supplied by water available in the bounded system (generally TRWD water in the modeled scenarios).

In addition to the existing infrastructure within its boundaries, the model also included certain TRWD projects that are in the development or construction phase, or have a high probability of being constructed. These included the planned constructed wetlands at Richland-Chambers and Cedar Creek Reservoirs, the recently completed Eagle Mountain Connection from the Rolling Hills Pump Station, and the future Fort Worth Southwest Water Treatment Plant.

In general, the model was formulated on three basic tenets, described in more detail in the sections below:

- Water distribution priorities and cost calculations establish a basis for **comparison**, **not allocation** between the two entities.
- The model was formulated to focus on opportunities and costs.
- Existing operating rules were suspended (except as discussed in section 2.2.3) and the optimization program was used to suggest effective operational practices and priorities.
- The model relied on existing data sources and models (such as TRWD's RiverWare model).

2.2.1 Water Distribution and Cost Calculations

Because the purpose of this modeling was to compare Baseline and Interconnected scenarios, modeling protocols were established to provide commonality between scenarios. These protocols did not represent actual operating agreements or allocate operational costs to individual entities. Instead, they established priorities for water distribution so that the modelers could experiment with the potential for water sharing and operational cost reduction. Results indicate opportunities, not designs.

A primary modeling protocol related to demand and the distribution of water. In Baseline scenarios (independent systems), DWU's demand and allocation from Lake Palestine were 102 mgd at all times and there was no access to TRWD supplies; though the supply reliability of the DWU raw water delivery system will decrease over time as additional water supplies are required, the overall Dallas system was not modeled (in order to emphasize the elements most directly affected by interconnection) and only the 102 mgd from Lake Palestine was included. In a Baseline scenario therefore, DWU always received 102 mgd and the model was used to optimize operating costs. In the Baseline TRWD scenario, it had sole access to its

supplies and the model considered the entire TRWD system (portions of which are only external demands to the pieces modeled in detail). The model was therefore used to calculate operating costs and supply reliability decreases over time as additional water supplies are required.

In Interconnected modeling scenarios, the model considered the potential for water delivery from Lake Palestine or any portion of the TRWD system to be the same. The purpose of the model was to therefore explore the potential for cost savings, redundancy, water sharing, and etc. by optimizing in a two-step process – first the reliability of deliveries to TRWD and DWU, and second optimizing the operational costs of that "highest reliability" run by iterating on alternative delivery pathways.

The first step required "prioritization" of deliveries to three entities: TRWD, DWU, and Ellis County. Because interconnection presents no advantage to DWU if it can no longer access the 102 mgd available in an independent system, the model ensured delivery of the full 102 mgd to DWU. This also assumes that the DWU demand does not gradually increase but rather is the entire 102 mgd from Lake Palestine. Because interconnection presents no advantage to TRWD if supply reliability is lower in an integrated system than an independent system, the model then optimized TRWD's reliability, which will still decrease over time because additional water supplies were not added to the model at the decade they are required in the future; the purpose was therefore to ensure that the hydraulic capacity is available to at least match the reliability it would produce under baseline conditions, not to ensure 100% reliability in the future. After these two supplies were optimized, the model allocated additional water supplies to Ellis County.

2.2.2 Primary Focus on Opportunities and Costs

The model was formulated to help identify opportunities for operational cost savings (see Section 3for capital and lifecycle cost analyses), water sharing and timing, redundancy, flexibility, and regional cooperation associated with an interconnected system. To fully explore the potential for such a system, most existing operating rules were suspended and the model employed an optimization program to route water through the system segments in a manner that would minimize deficits at demand nodes, and to do so at the lowest estimated operating costs. The system was constrained by pipeline capacities, reservoir storage, and water availability, and conveyance costs were computed on a monthly basis for each reach in the system (as shown in **Figure 2-1**).[1]

2.2.3 Simplified Operating Rules

The optimization program was used to suggest effective operational practices and priorities (such as when to draw from Lake Palestine, for example). Though the operating rules of the existing system were not enforced[2], the following operating

[1] See section 1.4.1 for limitations to the integrated operations model.
[2] This was done to avoid the potentially artificial restrictions of applying existing operating protocols to an integrated system that as yet does not exist.

rules were used in an effort to maintain general continuity with well-established existing protocols:

- Flow between points connected by more than one pipeline was divided equally between the pipes (on a capacity percentage basis).
- Existing conservation pool limits were enforced.
- Monthly minimum targets elevations for Lake Arlington were enforced. (540 feet from June- September, 535 feet October – May). Other reservoirs were operated within their specified conservation pools. These targets were found to have only a minimal influence on overall results.
- The model allowed scenarios to be formulated with or without the existing permitted yield constraints on Cedar Creek, Richland-Chambers, and Benbrook Reservoirs (these constraints accounted for contributions from proposed TRWD wetlands to Richland-Chambers and Cedar Creek Reservoirs). Pass-through water from Lake Palestine was also added to existing permitted yield constraints for Richland-Chambers and Cedar Creek where applicable. TRWD indicated that sedimentation rates projected in the Region C planning process for TRWD reservoirs appear to be overstated and actual rates will have a negligible effect on yield. As a result, sedimentation in the reservoirs was not accounted for in the optimization model.
- Holly WTP and Eagle Mountain WTP were supplied water from both the modeled East Texas system and the West Fork Trinity River. The City of Fort Worth, by special conditions in their water rights, was limited to take no more than 100,000 acre-feet per year from the West Fork. During drought conditions, defined as when the West Fork reservoirs (Lake Bridgeport, Lake Worth, and Eagle Mountain Lake) are at less than 50% capacity, the limit was reduced to no more than 46,000 acre-feet per year. These limits were enforced within the model by exporting the demand delivered by the West Fork to each WTP from the RiverWare model, then applying the remainder of the total projected demand for each WTP to the appropriate node in the model.

2.2.4 Reliance on Existing Models

Monthly demand values for each TRWD node within the model were extracted directly from the existing TRWD RiverWare model. Likewise, the hydrologic inflows to each reservoir within the bounded system were extracted directly from RiverWare. Because the DWU demand is bounded by the Lake Palestine yield, no additional data was required from an existing DWU system model.

2.3 Array of Operational Scenarios

The model allowed the formulation of a variety of scenarios, as shown on the screen capture of the model's interface screen in **Figure 2-2**. Various segments of the conveyance infrastructure were activated or deactivated for each scenario, allowing

the model to examine how best to utilize each pathway, and which ones would likely be most cost effective. Each scenario spanned a seven-year period on a monthly timestep and water availability was selected to represent comparatively normal conditions, or the drought of record. Hydrology was superimposed on future demand projections for TRWD and DWU through 2060.

The nearly endless array of possible scenarios was limited to those that clearly provided decision support regarding advantages or disadvantages of investing in infrastructure jointly or separately. These scenarios revealed opportunities for operational cost reductions, water sharing and timing, redundancy, and flexibility. These opportunities were tested for two conditions imposed on the model: permitted yield constrained and system operations. In the permitted yield constraint models (somewhat akin to a "firm yield" condition), the system is limited by conveyance capacity and all water supplies are limited by the lesser of their contracted/permitted amounts or firm yield amounts as defined by TCEQ. In the system operations condition, the model was constrained by lake levels, conveyance capacity and climate, but not by contracted/permitted values.

The following list explains the primary variables used to formulate each scenario:

- Conveyance Alternative: the four conveyance alternatives in **Table 1-1** were used to distinguish costs and benefits between baseline and interconnected alternatives.

- Optimization Objectives: Most scenarios were optimized to yield the highest supply reliability, and then, using those reliability targets, optimized to yield the lowest operational cost. In some experimental scenarios, the model was not optimized for cost because it did not contribute information needed to make decisions based on those particular scenarios.

- To test the impact of the TRWD constructed wetlands, capacity was set to full permitted amounts or zero.

- DWU demand: in experimental scenarios used to test the potential for water sharing, the DWU demand was prioritized behind TRWD and Ellis County and set at 1,000 mgd (essentially unlimited) and set at 0 mgd to test water sharing potential for TRWD.

- Application of existing permitted supply constraints. The model allowed scenarios to be formulated with or without the existing permitted yield constraints on Cedar Creek, Richland-Chambers, and Benbrook Reservoirs.

- Demands could be set by decade between 2010 and 2060.

- Hydrologic Condition: Each alternative could be tested during drought or normal hydrologic conditions.

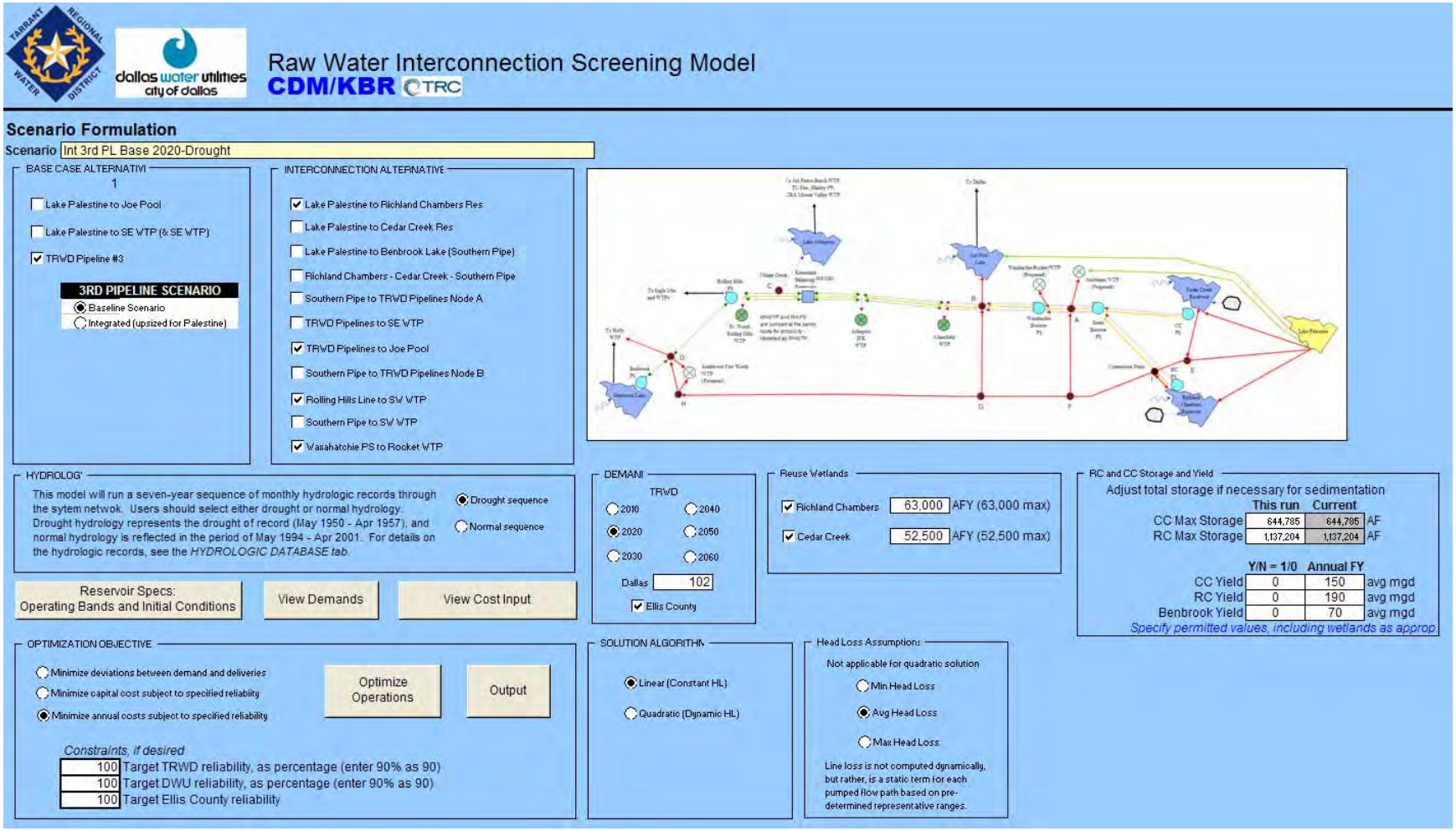


Figure 2-2
Scenario Formulation Interface

2.4 Conclusions from Integrated Operations Analysis

The purpose of this analysis was to identify opportunities for benefits, or potential disadvantages, to both TRWD and DWU through integrated operations of the raw water transmission systems from Lake Palestine, Richland-Chambers Reservoir, and Cedar Creek Reservoir. This comparison of Baseline Alternatives 1 and 2 with Interconnection Alternatives 3 and 4 (see **Table 1-1**) was driven by a system operations model and the team's water resource planning experience. This model was formulated as a decision-support system that permitted the user to create an array of scenarios that help answer a series of primary and secondary questions, formulated jointly by the project participants during workshops:

In this context, we can conclude the following regarding operating costs, water sharing and timing, redundancy, flexibility, and regional cooperation:

2.4.1 Operating Costs

As illustrated in **Figure 2-3**, the integrated operations modeling shows that operating costs within the bounded system (see **Figure 2-1**) are lower in interconnected alternatives as compared to baseline alternatives. This opportunity for operational cost savings is more pronounced in the near term and decreases over time as the difference between interconnected and independent operations is minimized. This near-term savings is attributed to the fact that the full amount of DWU water supply from Lake Palestine is not required immediately. (DWU access to the TRWD supply system could extend the need to connect the Lake Palestine supply to each system.)

2.4.2 Water Sharing and Timing

The integrated operations modeling found that there is opportunity to make extra water available to water user groups via an interconnected system. The analysis suggests that even under drought conditions in 2020, approximately 80 additional mgd could be available. This result is based on three modeling protocols: 1) water availability is limited by existing TRWD permits (for Richland-Chambers, Cedar Creek, and the planned wetlands); 2) DWU demand is equal to the contracted amount in Lake Palestine (102 mgd); and 3) conveyance is limited by the capacity of existing and planned TRWD conveyance facilities.

This result also confirms that Lake Palestine supply will be required prior to 2020 if the DWU demand reaches 102 mgd (though not all of it will be required immediately and dependence upon it as a source could conceivably be phased). Additions to conveyance capacity could be phased through 2030. TRWD requires water supply in addition to sources already included in the model, such as the reuse wetlands, between 2030 and 2040 (based on existing permit constraints and projected demands).

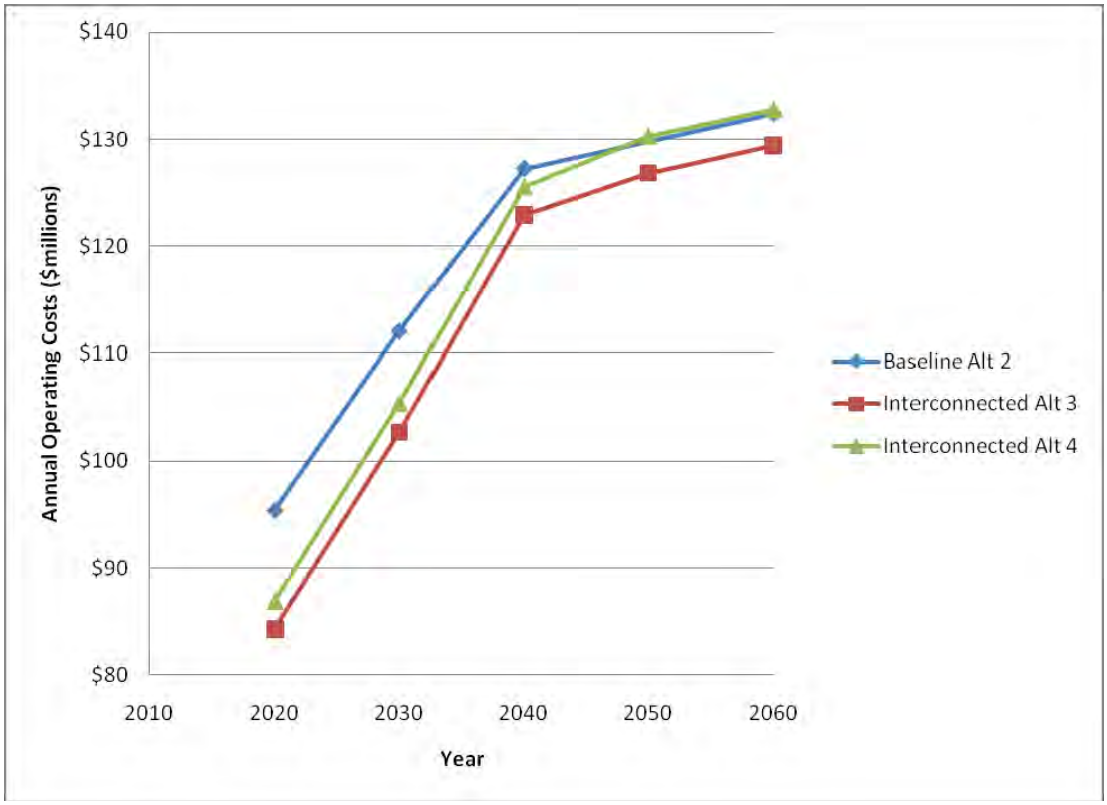


Figure 2-3
Summary of Operational Cost Opportunities Under Drought Conditions

Interconnection also provides the opportunity for TRWD to use the 102 mgd from Lake Palestine. This water sharing may be useful in an emergency situation or in a localized drought condition that causes deficit in the TRWD system while excess is available to DWU. This opportunity to share water between the two water providers is also a method of demand risk management to mitigate the effects of unforeseen demand growth patterns in the TRWD or DWU systems.

By the year 2030, any configuration of the system becomes supply limited, and reliability predictions during severe droughts would be roughly equivalent among configurations. However, during normal hydrologic periods, extra supply is available through 2060 in an interconnected system, though TRWD may have conveyance limitations to accessing the water. The analysis also indicates that the TRWD system can support sustained withdrawals above the current permitted levels. In other words, supply is limited by the permitted amounts, not water availability.

With an interconnected system, any additional water above projected demands would conceivably be available to any water user group, provided that conveyance capacity would be adequate. With separate systems, this water would not be available to DWU and TRWD and its customers would not benefit from potential sales or trades of water above projected TRWD customer demands. With an interconnected system, there is also the possibility of bringing other, currently independent sources (such as

DWU reuse water) and new water supply sources (Toledo Bend, Oklahoma, etc.) into the interconnected system to enhance the potential for water sharing.

To satisfy the DWU demands as they are represented in the model, the full yield of Lake Palestine (102 mgd) is needed immediately if the two systems remain separate. If conveyance systems are interconnected, use of Lake Palestine could ramp up gradually (assuming TRWD water supply in excess of projected demands could help satisfy DWU demand). This offers significant benefits with respect to phased infrastructure that are not available with separate systems.

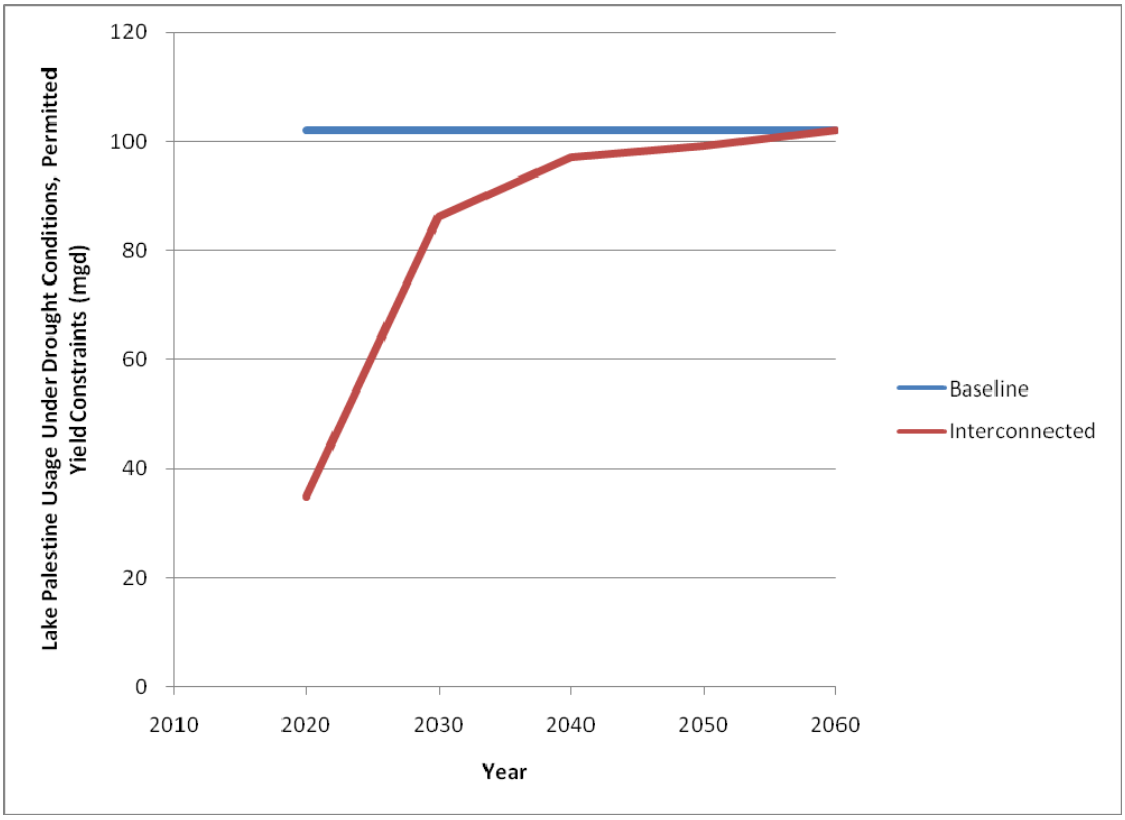


Figure 2-4
Potential Impact on Lake Palestine Timing (Assuming DWU Demand Constant at 102 mgd, Drought Conditions, Permitted Yield Constraints)

2.4.3 Redundancy

Operational redundancy is a "belt and suspenders" approach to risk management that enables the water supplier to select from multiple supply sources in times of emergency, drought, failure, etc. An interconnected supply system therefore provides more opportunity for supply and failure risk management.

In the event of a pipe failure or power outage, an integrated transmission system has more alternative flow pathways and connections to multiple water and power sources. These additional connections lower risk to the water provider. The impacts

of climatic variations are also lessened because of the diversification of reservoir locations. An interconnected system "casts a wider net" to reservoirs in different watersheds that will potentially experience drought in different times or levels of severity. Also, access to additional sources that may not be fully utilized adds supply redundancy to the system.

2.4.4 Operational Flexibility

Under prevailing ("normal") hydrologic conditions when the modeled system is not supply-limited, an interconnected system offers more operational flexibility than separate sources, since multiple flow pathways could be used to transport water. Such flexibility could be used to capitalize on advantageous opportunities for blending of sources, pump cycling schedules, system maintenance and energy management. One potential disadvantage of operations in an integrated system is the potential for increased operational complexity and the attendant new systems and protocols that must be developed to manage such a system.

The interconnected system also provides flexibility in terms of water availability. Extra supply is available through 2060 in an interconnected system and the analysis indicates that the TRWD system can support sustained withdrawals above the current permitted levels. This ability to overdraft supply sources provides flexibility to system operations, the potential for lower operating costs, and risk mitigation.

The National Water Research Institute in its November 2007 white paper entitled "Water 2010: A 'Near Sighted' Program of Water Resource Management Improvements for the Western United States" recommended system interties as its number one action item for state and local policymakers. NWRI concluded that "System interties increase the flexibility of system operators to respond to weather events, natural disasters, contaminations incidents, or the need to take water treatment or conveyance facilities temporarily off-line for repair or refurbishment……many interconnections can be planned and constructed within just a few years and at a relatively low cost."

2.4.5 Regional Cooperation

TRWD and DWU have a long history of cooperation in water supply planning, including the Texas Water Development Board regional water planning efforts initiated by the 1997 passage of Senate Bill 1 in the 75th session of the Texas Legislature. This on-going cooperation has led to this study and the potential for raw water transmission system interconnection. The interconnection of the two systems provides opportunities for benefit to both agencies by laying the groundwork for interconnecting future water supply sources (Toledo Bend, Oklahoma, etc.), increasing the portfolio of water supply options, reducing the costs of right-of-way through earlier acquisition, providing financing risk management, and compliance with TWDB planning guidelines.

The groundwork for regional cooperation in accessing future water supply options has already been laid; integrated water supply infrastructure provides additional opportunity for cost savings and will facilitate future inter-local agreements. By interconnecting the transmission system, each agency also effectively increases its portfolio of water supply options through the potential to share water and infrastructure.

Escalating costs for right-of-way acquisition (and urbanization) also point to the benefits of securing transmission routes early. This early acquisition presents an opportunity to acquire sufficient right-of-way for future joint water supplies. TRWD has recently experienced the following average costs for securing easements for several large diameter transmission system projects, costs which raise the issue of expedited acquisition of right-of-way for this and other future joint projects:

- Real estate classified as rural - $15,415 per acre.
- Real estate classified as undeveloped, planned - $33,792 per acre.
- Real estate classified as developed - $71,247 per acre.

Escalation in the cost of materials and ever increasing pressure on the financing market also point to the benefits of interconnection. Economies of scale and the ability to leverage the joint financing capacity of both agencies are benefits in integration.

Along with the other opportunities for benefits through integration, this regional cooperation is in compliance with TWDB guidelines for water supply planning. These guidelines and the TWDB planning process require this cooperation.

2.5 Summary Conclusion

From an operational perspective, the analysis supports further investigation of interconnected conveyance alternatives. Unlike separate systems, an interconnected system that routes Lake Palestine through the planned TRWD system offers reduced operating costs, cost sharing, savings due to infrastructure phasing, opportunities for water sharing, the potential for increased overall system yield and supply reliability, redundancy, and operational flexibility with respect to infrastructure scheduling and daily operations.

These results indicate a broad range of potential benefits that could be realized with an interconnected system as opposed to separate systems. Subsequent sections of this report address other factors relevant to interconnections, such as water quality, treatment requirements, environmental impacts, etc. Subsequent phases of work will establish operating protocols and cost agreements for shared conveyance and shared supply, and will address permitting needs.

Section 3
Lifecycle Cost Analysis

3.1 Purpose

The purpose of this cost analysis task was to develop a screening level/conceptual opinion of probable capital and lifecycle cost for each project conveyance alternative and to conduct a present worth economic comparison between the Baseline and Interconnection alternatives. The cost analyses represent total costs for water delivery and do not allocate costs between DWU and TRWD. The capital cost opinions presented herein are based on guidelines established by the Texas Water Development Board (TWDB) for use in regional water planning activities. The primary deviation from the TWDB guidelines is that the lifecycle cost analyses presented below consider escalation in power, operations and maintenance, and replacement costs while the TWDB guidelines specify development of a current (i.e., non-escalated) estimated annual cost for use in comparisons of alternative water management strategies.

The four project conveyance alternatives (described in **Table 1-1** and reproduced below for the reader's convenience) were compared in this cost analysis. The reader should refer to **Figures 1-4** through **1-8** for maps of pipeline routes used in each conveyance alternative.

Alternative	Description
1 (Baseline)	Independent Systems: TRWD's East Texas Third Pipeline and DWU's connection of Lake Palestine to the proposed Southeast Water Treatment Plant
2 (Baseline)	Independent Systems: TRWD's East Texas Third Pipeline and DWU's connection of Lake Palestine to Joe Pool Lake
3 (Interconnection)	Integrated System: Interconnected Third Pipeline (upsized as compared to the baseline condition) with connection of Lake Palestine to Cedar Creek Reservoir and delivery to DWU at Joe Pool Lake and TRWD's customers through the Third Pipeline
4 (Interconnection)	Integrated System: Interconnected "Southern Pipeline" - Lake Palestine delivered to the Lake Benbrook pipeline via a pipeline route to the south of the TRWD Third Pipeline route. Delivery to DWU at Joe Pool Lake and TRWD's customers through connections to the existing system and the Lake Benbrook pipeline.

Screening level/conceptual capital cost analyses for each project conveyance alternative are presented below. Background information and the results of the life-cycle cost analysis are then presented along with a discussion of the life-cycle cost analysis method. The reader should refer to section 1.4.2 for a discussion of the uncertainties and limitations associated with the development of this preliminary cost analysis and section 1.4.3 for recommendations for future cost analyses that will help refine the cost information and provide differentiation between Interconnection alternatives.

3.2 Capital Cost Analysis

The conceptual capital cost estimates for each project conveyance alternative are presented in **Table 3-1**. The table also contains the component pieces of the baseline alternatives broken down into individual capital cost estimates. The pipelines that compose these conveyance alternatives are:

TRWD Baseline Third Pipeline

- Cedar Creek to Ennis Pump Station
- Richland-Chambers to Ennis Pump Station
- Ennis Pump Station to Rolling Hills Water Treatment Plant

DWU Baseline

- Lake Palestine to Southeast WTP; or
- Lake Palestine to Joe Pool Lake

Interconnected Third Pipeline

- Lake Palestine to Cedar Creek Reservoir
- Cedar Creek Reservoir to Ennis Pump Station
- Richland-Chambers to Ennis Pump Station
- Ennis Pump Station to Rolling Hills Water Treatment Plant

Interconnected Southern Pipeline

- Lake Palestine to Lake Benbrook (Southern Route)
- Cedar Creek to Southern Pipeline
- Richland-Chambers Reservoir to Southern Pipeline
- Southern Pipeline to Joe Pool Lake Interconnect (interconnect w/TRWD Lines but effectively adjacent to Joe Pool connection)

Table 3-1
Results of Conceptual Capital Cost Analysis

Baseline Alternatives	Capital Cost (2008 basis)
Alternative 1: TRWD Third Pipeline + DWU Lake Palestine to SE WTP	$1,177,844,000
(Component 1: DWU Lake Palestine to SE WTP)	(548,949,000)
(Component 2: TRWD Third Pipeline)	(628,894,000)
Alternative 2: TRWD Third Pipeline + Lake Palestine to Joe Pool Lake	$1,303,360,000
(Component 1: DWU Lake Palestine to Joe Pool Lake)	(674,466,000)
(Component 2: TRWD Third Pipeline)	(628,894,000)
Interconnection Alternatives	
Alternative 3: Interconnected Third Pipeline	$1,083,966,000
Alternative 4: Interconnected Southern Pipeline	$1,355,279,000

3.3 Lifecycle Cost Analysis

Results from the screening level life-cycle cost analyses are shown in **Table 3-2** and **Table 3-3**. **Table 3-2** presents results on a total cost basis over 50 years, a Present Value basis (2008 dollars), and on a unit cost basis (i.e. cost per 1,000 gallons). The comparison of life-cycle costs for each project conveyance alternative is presented in **Table 3-3**.

Each of the primary variables in these lifecycle calculations are described in the sections below **Table 3-4**. These variables were: debt service and the discount rate, renewal and replacement costs, operational (energy) costs, and operations and maintenance.

Unit costs are specifically excluded from these results because only a portion of the DWU and TRWD transmission systems were modeled and because costs and water volumes were not allocated between the two entities in this study (this analysis will be necessary in subsequent phases).

Table 3-2
Lifecycle Cost Analysis Results

Baseline Alternatives	Total Cost (50-year Life)	Present Value Cost
Alternative 1: TRWD Third Pipeline + DWU Lake Palestine to SE WTP	$6,043,044,000	$2,462,651,000
(Component 1: DWU Lake Palestine to SE WTP)	(2,738,178,000)	(1,198,104,000)
(Component 2: TRWD Third Pipeline)	(3,304,866,000)	(1,264,547,000)
Alternative 2: TRWD Third Pipeline + Lake Palestine to Joe Pool Lake	6,774,762,000	$2,776,834,000
(Component 1: DWU Lake Palestine to Joe Pool Lake)	(3,469,896,000)	(1,512,287,000)
(Component 2: TRWD Third Pipeline)	(3,304,866,000)	(1,264,547,000)
Interconnection Alternatives		
Alternative 3: Interconnected Third Pipeline	5,578,924,000	2,238,879,000
Alternative 4: Interconnected Southern Pipeline	6,306,874,000	2,740,189,000

*Note that interconnected alternatives include delivery to Joe Pool Lake, not the SEWTP.

Table 3-3
Lifecycle Cost Differences – Comparison of Project Conveyance Alternatives

Interconnection Alternative	Comparison Baseline Alternative	Total Cost Difference	Present Value Cost Difference
3 (Interconnected Third Pipeline)	1 (w/ Pal. to SE WTP)	$464,120,000	$223,771,000
3 (Interconnected Third Pipeline)	2 (w/ Pal. to Joe Pool)	1,195,837,000	537,954,000
4 (Interconnected Southern Pipeline)	1 (w/ Pal. to SE WTP)	$-263,830,000	$-277,538,000
4 (Interconnected Southern Pipeline)	2 (w/ Pal. to Joe Pool)	467,887,000	36,644,000

*Note that interconnected alternatives include delivery to Joe Pool Lake, not the SEWTP.

3.3.1 Discount Rate

The discount rate is calculated as the cost of debt for the organization that will build the project and is then adjusted as needed to account for elements of risk unique to each project scenario. Because all variables in this life-cycle cost analysis are costs (as opposed to investments), a higher discount rate is favorable; additional risk factors decrease the discount rate as opposed to the traditional increase that would typically occur in an "investment scenario". For the DWU Baseline alternatives, the cost of debt was assumed to be 4.88%, which is equal to the simple average of the interest rates for the series of bonds in the 2006 Waterworks and Sewer System Revenue Refunding and Improvement Bonds from the City of Dallas 2006 Annual Report. For the TRWD Baseline alternative, the cost of debt was assumed to be 5.07%, which is equal to the TRWD 2006 Series Water Revenue Bonds' average annual interest rate. For the Interconnected alternatives, 4.97% was used, which is the simple average of the cost of debt for DWU and TRWD.

With the discount rate set equal to the cost of debt quoted above, risk factors were then identified and quantified in terms of a percentage reduction in the discount rate. The following risk factors were quantified based on the team's expert opinion:

- Political Risk: As a consequence of DWU and TRWD having to coordinate efforts in an interconnected alternative, both of these alternatives were deemed to have some political risk resulting from a potential delay in construction of one year. The cost of this political risk was quantified as 0.20 percent.

- Construction Delay: A reduction in the Interconnected Southern Pipeline alternative discount rate was applied to account for the potential delays associated with real estate acquisition (e.g., easements for pipelines). It was assumed that pipeline construction could begin prior to and concurrent with acquisition of all required easements. This risk was quantified as 0.40 percent to reflect a potential two-year delay in construction. Similarly, a reduction in the DWU Baseline alternatives' discount rate was quantified as 0.30 percent to represent an 18 month delay associated with procuring right-of-way easements. This delay is assumed to be less than the delay for the Interconnected Southern Pipeline alternative because of the relatively shorter pipeline length required for the DWU Baseline alternatives.

The discount rates applied in the 50-year life cycle cost analysis for each component of the project conveyance alternatives are summarized below in **Table 3-4**.

Table 3-4
Discount Rates

Components of Baseline Alternatives	Discount Rate	Interconnection Alternatives	Discount Rate
Lake Palestine to Joe Pool Lake		Interconnected 3rd Pipeline	
Cost of Debt	4.88%	Cost of Debt	4.97%
Cost of Delay	-0.30%	Political Risk	-0.20%
Total	4.58%	Total	4.77%
Lake Palestine to SE WTP			
Cost of Debt	4.88%	Southern Pipeline	
Cost of Delay	-0.30%	Cost of Debt	4.97%
Total	4.58%	Political Risk	-0.20%
TRWD Third Pipeline		Cost of Delay	-0.40%
Cost of Debt	5.07%	Total	4.37%
Total	5.07%		

3.3.2 Renewal and Replacement Costs

Some infrastructure elements will require replacement during the 50-year life-cycle of the system. The renewal and replacement analysis captured this element of cost for each project scenario. An example of renewal and replacement cost assumptions applied to the Interconnected Third Pipeline is shown in the **Table 3-5**.

Table 3-5
Renewal and Replacement: Average Years to Renewal

	Channel Dam / Intake	Pump Stations (Elec/Mech Equipment)	Tanks	Pipelines	Disinfection /Surge Control
Average Years to Renewal	50	30	50	50	25

It was assumed that only the pump stations and disinfection/surge control equipment are likely to require replacement during the 50-year project life-cycle. Estimated equipment life was obtained from the TCEQ System of Accounts, June 1999. It was assumed that 40 percent of the original capital costs will be required to replace certain elements of the pump station facilities and that the remaining 60 percent represents structural components, which have a significantly longer life expectancy. The pump station replacement cost was increased by another 20 percent to act as a contingency for unquantified pump station renewal costs.

For this analysis, the disinfection/surge control equipment was assumed to require 100 percent replacement and an additional 20 percent was added for contingency. The renewal and replacement costs for both pump stations and disinfection/surge control equipment were then inflated by the projected long-term U.S. inflation rate to estimate the capital costs at the time of renewal or replacement.

3.3.3 Energy Costs

Energy costs were calculated as the product of an assumed energy rate and the usage for each project conveyance alternative. The energy usage was based on the system operations model (see Section 2), which calculated operational costs (energy) in kilowatt hours (kWh) over seven years of assumed hydrologic conditions, either drought or normal. For the life-cycle cost analysis, energy usage during normal hydrologic conditions was used to represent average conditions over the 50-year life-cycle.

The energy rate was based on data from the Electric Reliability Council of Texas (ERCOT) for electric power delivered within the ERCOT North Texas Zone; an energy rate of $0.084/kwh was used in this analysis .This rate was not escalated over the course of the 50-year lifecycle of each project based on the US Department of Energy Annual Energy Outlook 2008 Energy Prices by Sector and Source forecast.

3.3.4 Operations and Maintenance Costs

Operations and maintenance (O&M) costs for each project alternative were calculated in accordance with Texas Water Development Board (TWDB) guidelines for regional water supply planning. TWDB guidelines provide an estimated fixed percentage of construction cost for various types of facilities to estimate O&M costs. The construction cost is the capital cost for each facility type and does not include financing or other related costs.

O&M costs were escalated over time using the inflation rate, projected as the long-term U.S. inflation rate according to the U.S. Bureau of Labor Statistics. Its intent was to capture the increase in wages and other costs associated with operations and maintenance. Energy costs were not included in this O&M cost calculation because they were considered independently. An example of the estimated annual O&M costs for the Interconnected Third Pipeline alternative is shown in **Table 3-6**.

Table 3-6
Operations and Maintenance as a Percentage of Construction Cost

	Channel Dam / Intake	Pump Stations	Tanks	Pipelines	Disinfection / Surge Control
O&M as % of Construction Cost	1.50%	2.50%	2.50%	1.00%	2.50%

3.4 Lifecycle Cost Analysis Conclusions

The purpose of the cost analysis task was to develop a screening level/conceptual opinion of probable capital and lifecycle cost for each project conveyance alternative and to conduct a present worth economic comparison between the Baseline and Interconnection alternatives. Results were presented above in **Tables 3-2** and **3-3** and show that there are opportunities for significant cost savings through an integration of the raw water transmission systems to deliver Lake Palestine water to DWU and TRWD.

Delivering water through an Interconnected Third Pipeline has potential Present Value, 50-year life-cycle cost savings between approximately $220,000,000 and $540,000,000.

The Interconnected Southern Pipeline alternative has potential Present Value, 50-year life-cycle cost savings when compared to Alternative 2 (baseline with delivery to Joe Pool) but increased cost when compared to Alternative 1 (baseline with delivery to SE WTP). However, because the Interconnected Southern Pipeline delivers water to Joe Pool Lake and not the SE WTP, the most direct comparison is between the Interconnected Southern Pipeline and Alternative 2, which results in an approximate $36,600,000 savings. Subsequent phases of this feasibility assessment will consider other potential benefits from the Southern Pipeline, such as supply risk reduction and right-of-way acquisition for future supplies. For example, TRWD has recently experienced the following average costs for securing easements for several large diameter transmission system projects:

- Real estate classified as rural - $15,415 per acre.
- Real estate classified as undeveloped, planned - $33,792 per acre.
- Real estate classified as developed - $71,247 per acre.

These costs raise the issue of expedited acquisition of right-of-way (e.g. in the Southern Pipeline route) to manage the availability and cost of acquisition for this and future water supplies. Also, phasing could also result in significant reduction of costs associated with the Interconnected Southern Pipeline due to the potential to defer development of transmission facilities required to deliver water to Lake Benbrook.

Section 4
Constraints Analysis

A preliminary facility siting constraints analysis was performed to identify potential fatal flaws to locating water transmission facilities along select pipeline corridors and to make a comparison between project conveyance alternatives. The data collected for the constraints analysis will also have use during subsequent phases of engineering. The preliminary constraints analysis was accomplished using publicly available data from secondary sources (no field data collection). A database of constraint data and aerial photography was developed using Geographic Information System (GIS) applications software. Using this spatial data, a team of subject matter experts identified potential facility siting constraints in three categories: land use, environmental, and technical (engineering). After relevant data was compiled and analyzed for each potential constraint, subject matter experts rated the potential for impact as "High", "Medium", "Low", or "No Impact" and the team then came to a consensus on the overall potential impact on each transmission corridor.

The facility siting constraints analysis is summarized in the Alternatives Evaluation Matrix (AEM). This tool is simply a tabulation of the constraints within the three impact categories, beginning with the generalized "Impact Category", which is then broken down into "Evaluation Criteria", which are comprised of "Components". Basic facility data is also included in the AEM to identify each alternative and quantify dimensions and capacities of water transmission infrastructure.

This section summarizes the constraints analysis. First is a description of the infrastructure components in each of the four scenarios. Next is a discussion of the Alternatives Evaluation Matrix (AEM). Lastly, preliminary findings and consensus evaluations are presented.

4.1 Description of Alternatives

Like all other project analyses, the constraints analysis compared four project conveyance alternatives, which are listed in **Table 1-1** and reproduced here for the reader's convenience.

Alternative	Description
1 (Baseline)	Independent Systems: TRWD's East Texas Third Pipeline and DWU's connection of Lake Palestine to the proposed Southeast Water Treatment Plant
2 (Baseline)	Independent Systems: TRWD's East Texas Third Pipeline and DWU's connection of Lake Palestine to Joe Pool Lake
3 (Interconnection)	Integrated System: Interconnected Third Pipeline (upsized as compared to the baseline condition) with connection of Lake Palestine to Cedar Creek Reservoir and delivery to DWU at Joe Pool Lake and TRWD's customers through the Third Pipeline
4 (Interconnection)	Integrated System: Interconnected "Southern Pipeline" - Lake Palestine delivered to the Lake Benbrook pipeline via a pipeline route to the south of the TRWD Third Pipeline route. Delivery to DWU at Joe Pool Lake and TRWD's customers through connections to the existing system and the Lake Benbrook pipeline.

A brief description of the facilities used in each alternative, and the basis for their selection, follows. The reader should refer to **Figures 1-4 through 1-8** for mapping of the infrastructure components that make up each of the four project conveyance alternatives.

DWU Baseline – Palestine to Southeast WTP

DWU's primary baseline alternative for connecting Lake Palestine to the DWU service area is to construct a pipeline directly from Lake Palestine to the site of the proposed Southeast Water Treatment Plant (WTP) in Hutchins, TX. This baseline alternative consists of three principal components:

- An intake pump station at Lake Palestine;
- A single 84 inch pipeline from Lake Palestine to the Southeast WTP; and
- A booster pump station at Murchison, TX.

Almost two decades have passed since planning level studies were completed for this project alternative, which at the time included site selection for the Southeast WTP and the intake at Lake Palestine, and an alignment study for the transmission pipeline (see Lake Palestine Utilization and Pipeline Alignment Study, by Dannenbaum Engineering Corporation, June 1989). The recommended pipeline alignment and locations for the intake and WTP were used in this constraints analysis.

According to DWU staff, the Southeast WTP location recommended in the previous study is favorable for interconnection with the DWU distribution system. However, the WTP site is adjacent to two intermodal transportation facilities that will make development of a facility at that site difficult. The location of the WTP could be moved longitudinally along the previously studied pipeline alignment but suitable alternative sites are not readily available.

DWU Baseline – Lake Palestine to Joe Pool Lake

An alternative stand-alone baseline project for DWU is to construct a pipeline from Lake Palestine to Joe Pool Lake. This baseline alternative consists of three principal components:

- An intake pump station at Lake Palestine;
- A single 84 inch pipeline from Lake Palestine to Joe Pool Lake; and
- Two booster pump stations.

This baseline alternative was proposed for evaluation by DWU due to potential limitations to the original proposed site for the Southeast WTP. Delivery of Lake Palestine water to Joe Pool Lake offers potential advantages in terms of development of a new WTP in proximity to portions of the DWU service area where additional supplies are needed. A WTP site near Mountain Creek Lake would provide treatment capacity in close proximity to the high, medium, and low pressure planes of the DWU service area. Alternatively, Lake Palestine water supplies could be transferred from Joe Pool Lake to the existing DWU Bachman WTP (see Section 8 of this report), thereby freeing up raw water supplies from Lake Lewisville and Lake Ray Roberts for expansion of the DWU Elm Fork WTP.

Because the corridor between the Southeast WTP site and Joe Pool Lake is largely urbanized, the pipeline alignment for this baseline alternative would not follow the same route proposed for delivery to the Southeast WTP. Instead, it would follow a more southerly route from Lake Palestine to Joe Pool Lake, passing between the Richland-Chambers and Cedar Creek Reservoirs.

TRWD Baseline – Third Pipeline

TRWD's baseline alternative is to construct additional conveyance capacity to deliver water from Richland-Chambers Reservoir and Cedar Creek Lake to as far west as Rolling Hills WTP and intermediate delivery points. This "East Texas Third Pipeline" would share existing right-of-way with two existing TRWD pipelines. TRWD's baseline alternative consists of six principal components:

- Additional intake capacity at Richland-Chambers Reservoir and a 60 inch pipeline to the existing TRWD Ennis Booster Pump Station;
- Additional intake capacity at Cedar Creek Lake and a 72 inch pipeline to the Ennis Booster Pump Station;
- A single 84 inch pipeline to carry the combined additional flow from the Ennis Booster Pump Station to existing TRWD balancing reservoirs at Kennedale;
- A bi-directional 96 inch pipeline from the Kennedale balancing reservoirs to the Rolling Hills WTP;

- Additional pumping capacity at the existing TRWD pump stations at Ennis and Waxahachie; and

Because of the potential to share existing pipeline right-of-way and booster pump station infrastructure, the Third Pipeline is thought to be the lowest cost baseline alternative for TRWD to deliver additional raw water from its East Texas reservoirs

Interconnected Third Pipeline

This alternative would deliver raw water supplies from Lake Palestine through an interconnected system to both TRWD and DWU. This alternative includes the same principal components as the above TRWD baseline alternative, up-sized for the additional flow from Lake Palestine, and the following additional components:

- An intake pump station at Lake Palestine;
- A single 72 inch pipeline from Lake Palestine to Cedar Creek Reservoir; and
- A turnout from the Third Pipeline to deliver water to Joe Pool Lake.

Interconnected Southern Pipeline

This project conveyance alternative was considered as an option to the Interconnected Third Pipeline because of the potential benefits to system reliability (three pipelines in one shared transmission corridor may increase the risk of failure for all three lines and therefore lower the reliability of the East Texas supply), right-of-way acquisition, and phasing. This alternative would provide an alignment and reserve right-of-way for the transmission of future water supplies from East Texas and consists of the following principal components:

- An intake pump station at Lake Palestine;
- A single 108 inch pipeline from Lake Palestine to Benbrook Lake;
- A bi-directional 66 inch interconnection pipeline from Richland-Chambers Reservoir;
- A bi-directional 72 inch interconnection pipeline from Cedar Creek Lake;
- A 108 inch interconnection pipeline to Joe Pool Lake;
- Three booster pump stations.

The Interconnected Southern Pipeline would pass between Richland-Chambers and Cedar Creek Reservoirs. Interconnections with both reservoirs would provide flexibility to deliver Lake Palestine water into these reservoirs for temporary storage or to add supply from these lakes to the joint transmission line. These interconnects would increase operational flexibility and yield reliability.

Pipeline Corridors

At this stage of the Lake Palestine Project Viability Assessment, pipeline alignments were defined broadly, in spatial terms. The constraints analysis was performed on a two-mile wide corridor for each pipeline segment around an assumed centerline. Constraints data was analyzed to indicate the potential for utility, environmental, and other conflicts within each corridor rather than along the assumed centerline. The assumed centerline was defined by the project team by first assuming the shortest route between the beginning and end points, and then deviating from that line in consideration of apparent conflicts (e.g., towns, major water courses, road crossings, etc.). **Figure 4-1** shows an approximate centerline longitudinal surface elevation profile for some of the primary alternative routes.

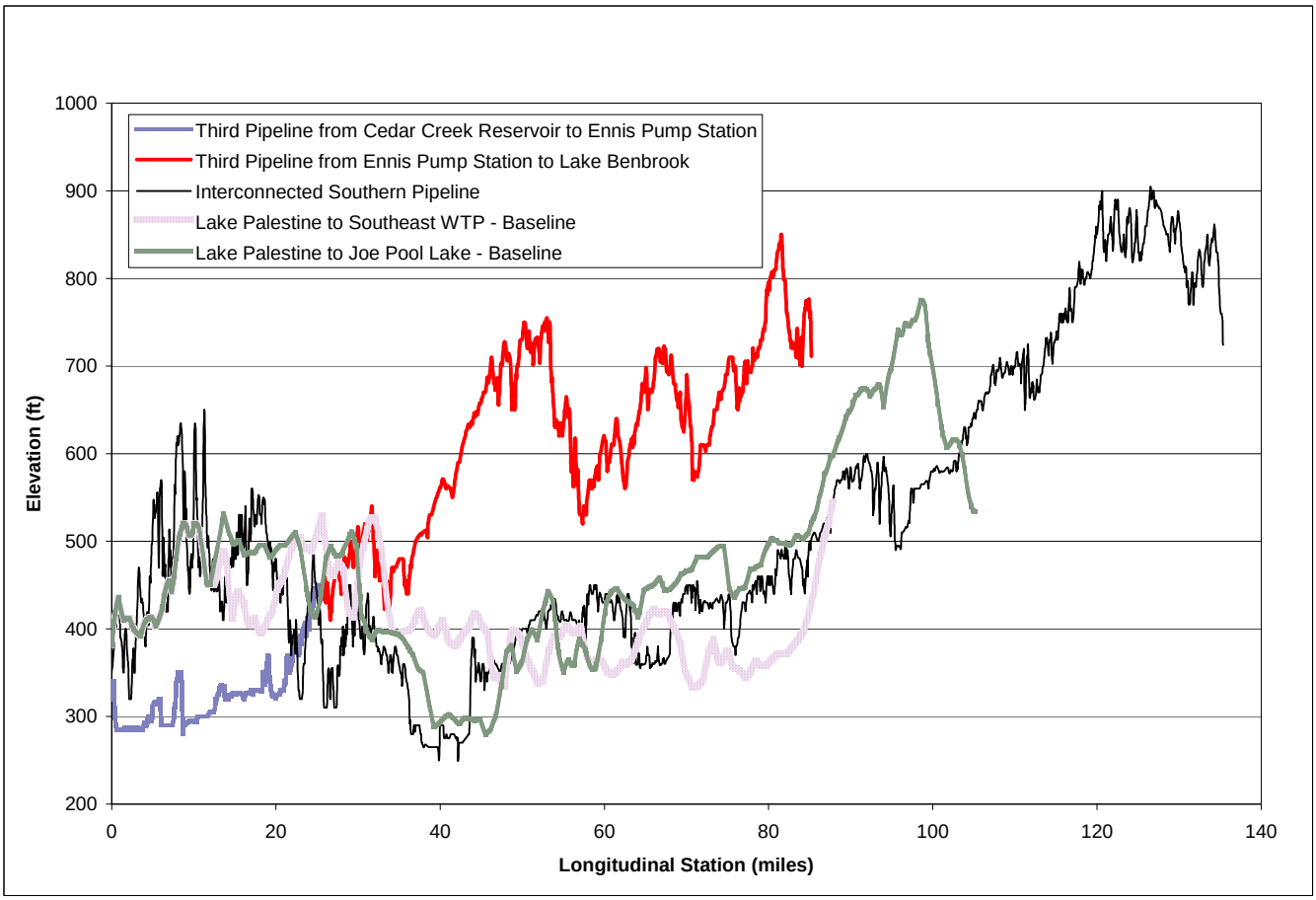


Figure 4-1
Approximate Pipeline Longitudinal Surface Elevation Profiles

4.2 Alternatives Evaluation Matrix

An Alternatives Evaluation Matrix (AEM) was developed to evaluate the occurrence and level of constraints for each pipeline in the project scenarios. This tool is simply a tabulation of the constraints within three classifications, beginning with the generalized "Impact Category", which is then subdivided into "Evaluation Criteria", which are further subdivided into "Components".

1. Impact Categories – Basic Data (not constraints, but necessary to the evaluation), Land Use, Environmental, and Technical (Engineering)

2. Evaluation Criteria – This subset of the impact categories represents the place at which ratings were assigned to the potential impact of constraints on a project alternative. For example, in the environmental impact category, the wetlands criteria may be rated as a High, Medium, Low, or None based on the data analyzed for each component.

3. Components – Each criterion is composed of several components, or attributes data, that become the basis for rating the potential impact. To continue with the previous example, the wetlands criteria components include forested wetlands, non-forested, waters of the U.S., etc.

The impact categories and evaluation criteria selected for the AEM are listed in **Table 4-1**.

To support the constraints analysis process, data were collected from reliable sources and stored in an ArcGIS 9 environment using a common spatial projection. A series of constraint maps were then designed so that the team could visualize potential constraints and their interrelationship. A list of the data and sources used for this analysis is shown in **Table 4-2**.

The final products of the constraints analysis were: 1) a collection of data needed for future phases of engineering, such as conceptual and preliminary design; and 2) a qualitative rating of the potential impact on each evaluation criteria and a consensus evaluation of the overall potential impact of the identified constraints on each project conveyance alternative. Subject matter experts provided an opinion based on the constraints data and rated the evaluation criteria. After each component was quantified and the evaluation criteria were rated, the evaluation team reached consensus on the overall potential impact rating for each scenario.

Table 4-1
Constraint Evaluation Criteria

Impact Category	Category ID No.	Evaluation Criteria
Basic Data	B.1	Intake Facilities; Intake pump station
	B.2	Transmission Facilities Pipelines and Booster PS
Land Use	L.1	Residences
	L.2	Commercial Businesses
	L.3	Schools
	L.4	Parks and Recreation Areas
	L.5	Oil & Gas
	L.6	Other Wells
	L.7	Hazardous Material Sites
	L.8	Airports
	L.9	Mines
	L.10	Existing Roads, Highways and Railroads
	L.11	Agriculture & Non-Tillable Land Based on Soil Type
	L.12	Land Use
Environmental	E.1	Vegetation
	E.2	Conservation
	E.3	Noise
	E.4	Wetlands/Water of the US
	E.5	Wildlife Habitats
	E.6	Cultural Resources
	E.7	Visual
Technical (Engineering)	T.1	Drainage and Hydrologic
	T.2	Electric Transmission Lines
	T.3	Topography
	T.4	Proximity to Infrastructure
	T.5	Site Conditions

Table 4-2
List of Source and Data Used in Constraint Analysis

Source	Base Map Data
National Hydrography Dataset/EPA	Streams
	Waterbodies
Texas Natural Resource Information System	Contours
	USGS Topographic Map Grid
Texas Railroad Commission	Abstracts
US Census Bureau	Cities
	Parks
	Streets
Source	**Constraint Data**
ERCOT	Electrical Transmission
Texas Commission on Environmental Quality	Impaired Streams
	Impaired Water Bodies
	Permitted Industrial Hazardous Waste Sites
	Radioactive Waste Sites
	Superfund Cleanup Sites
	Surface Water Rights
	Wastewater Outfalls
Texas Education Agency	School Districts
	Schools
Texas Historical Commission	Historical Markers
Texas Historical Commission and USGS	Cemeteries
Texas Parks and Wildlife	State Parks
	Threatened and Endangered Species
	Vegetation Type
Texas Railroad Commission	Oil and Gas Pipelines
	Oil and Gas Wells
Texas Water Development Board	Groundwater Wells
United States Department of Agriculture	Soils/Farm Lands
US Census Bureau	Airports
USGS	Land Use
USGS/National Atlas	Agricultural Mine
	Crushed Stone Mines
	Federal Lands
	National Parks
	Sand/Gravel Mines

4.3 Preliminary Findings and Consensus Evaluations

The preliminary findings of the constraints analysis are contained in the Alternatives Evaluation Matrix (AEM), with an analysis of each evaluation criterion and component, and an impact rating for each evaluation criterion. Using the ratings from each impact category and the opinions of the subject matter experts, a consensus evaluation was reached for each project conveyance alternative. The consensus evaluation is summarized in **Table 4-3**, **Table 4-4** and **Table 4-5.**

The evaluation team agreed that, based on the available data, no fatal flaws were detected in this analysis and each of the pipeline corridors are potentially viable and can be recommended for further analysis.

The consensus evaluations in **Table 4-3**, **Table 4-4** and **Table 4-5** also show that, based on the available data, there are no significant differentiators between project alternatives in terms of land use, environmental, or technical (engineering) constraints. Differentiation in terms of lifecycle cost, reliability, operations and maintenance, water quality, and other factors is addressed in other sections of this report. Subsequent phases of project definition and development will provide the quantitative data needed to differentiate the occurrence and significance of constraints within each alternative pipeline corridor

Table 4-3
Baseline Alternatives Constraints Analysis Consensus Evaluations

Impact Category	Category ID No.	Evaluation Criteria	Baseline				
			DWU 2	DWU 1	TRWD		
			Palestine to JP	Palestine to SE WTP	CC to Ennis	RC to Ennis	Ennis to RHWTP
Basic Data	B.1	Intake Facilities; Intake pump station	--	--	--	--	--
	B.2	Transmission Facilities Pipelines and Booster PS	--	--	--	--	--
Land Use	L.1	Residences	Low	Low	Low	Low	Low
	L.2	Commercial Businesses	Low	Low	Low	Low	Low
	L.3	Schools	None	None	None	None	None
	L.4	Parks and Recreation Areas	None	Low	None	None	Low
	L.5	Oil & Gas	Med	Low	Low	Med	High
	L.6	Other Wells	Low	Low	Low	Low	Low
	L.7	Hazardous Material Sites	Low	Low	Low	Low	Low
	L.8	Airports	Low	Low	Low	Low	Low
	L.9	Mines	Low	Low	Low	Low	Low
	L.10	Existing Roads, Highways and Railroads	Med	Med	Low	Med	High
	L.11	Agriculture & Non-Tillable Land Based on Soil Type	Low	Low	Low	Low	Low
	L.12	Land Use	Med	Med	Low	Low	Med
Environ-mental	E.1	Vegetation	Med	Med	Low	Low	Med
	E.2	Conservation	None	None	None	None	None
	E.3	Noise	Low	Low	Low	Low	Low
	E.4	Wetlands/Water of the US	Med	Med	Low	Med	Med
	E.5	Wildlife Habitats	Med	Med	Med	Med	Med
	E.6	Cultural Resources	Med	Med	Low	Low	Med
	E.7	Visual	Low	Low	Low	Low	Low
Technical (Engin-eering)	T.1	Drainage and Hydrologic	Med	Med	Low	Low	Low
	T.2	Electric Transmission Lines	Med	Low	Low	Low	High
	T.3	Topography	Low	Low	Low	Low	Low
	T.4	Proximity to Infrastructure	Low	Low	Low	Low	Low
	T.5	Site Conditions	Med	High	Med	low	Low
Consensus Evaluation of Constraint Level			Med	Med	Low	Low	Med

Table 4-4
Interconnected Third Pipeline Alternative Constraints Analysis Consensus Evaluations

Impact Category	Category ID No.	Evaluation Criteria	Interconnected Third Pipeline			
			Pal to CC	CC to Ennis PS	RC to Ennis	Ennis to RHWTP
Basic Data	B.1	Intake Facilities; Intake pump station	--	--	--	--
	B.2	Transmission Facilities Pipelines and Booster PS	--	--	--	--
Land Use	L.1	Residences	Low	Low	Low	Med
	L.2	Commercial Businesses	Low	Low	Low	Low
	L.3	Schools	None	None	None	None
	L.4	Parks and Recreation Areas	None	None	None	None
	L.5	Oil & Gas	Med	Low	Med	High
	L.6	Other Wells	Low	Low	Low	Low
	L.7	Hazardous Material Sites	Low	Low	Low	Low
	L.8	Airports	Low	Low	Low	Low
	L.9	Mines	Low	Low	Low	Low
	L.10	Existing Roads, Highways and Railroads	Med	Low	Med	High
	L.11	Agriculture & Non-Tillable Land Based on Soil Type	Low	Low	Low	Low
	L.12	Land Use	Low	Low	Low	Med
Environ-mental	E.1	Vegetation	Low	Low	Low	Med
	E.2	Conservation	Low	None	None	None
	E.3	Noise	Low	Low	Low	Low
	E.4	Wetlands/Water of the US	Med	Low	Med	Med
	E.5	Wildlife Habitats	Med	Med	Med	Med
	E.6	Cultural Resources	Low	Low	Low	Med
	E.7	Visual	Low	Low	Low	Low
Technical (Engin-eering)	T.1	Drainage and Hydrologic	Med	Low	Low	Low
	T.2	Electric Transmission Lines	Low	Low	Low	High
	T.3	Topography	Low	Low	Low	Low
	T.4	Proximity to Infrastructure	Low	Low	Low	Low
	T.5	Site Conditions	High	Med	Low	Low
Consensus Evaluation of Constraint Level			Med	Low	Low	Med

Table 4-5
Interconnected Southern Pipeline Alternative Constraints Analysis Consensus Evaluations

Impact Category	Category ID No.	Evaluation Criteria	Interconnected Southern Pipeline			
			Pal to Benbrook	CC to Southern Rte	RC to Southern Rte	So Rte to JP (intcnct)
Basic Data	B.1	Intake Facilities; Intake pump station	--	--	--	--
	B.2	Transmission Facilities Pipelines and Booster PS	--	--	--	--
Land Use	L.1	Residences	Low	Low	Low	Low
	L.2	Commercial Businesses	Low	Low	Low	Low
	L.3	Schools	None	None	None	None
	L.4	Parks and Recreation Areas	None	None	None	None
	L.5	Oil & Gas	High	Low	High	High
	L.6	Other Wells	Low	Low	Low	Low
	L.7	Hazardous Material Sites	Low	Low	Low	Low
	L.8	Airports	Low	Low	Low	Low
	L.9	Mines	Low	Low	Low	Low
	L.10	Existing Roads, Highways and Railroads	High	Med	High	Med
	L.11	Agriculture & Non-Tillable Land Based on Soil Type	Low	Low	Low	Low
	L.12	Land Use	Low	Low	Low	Low
Environ-mental	E.1	Vegetation	Med	Low	Low	Low
	E.2	Conservation	None	None	None	None
	E.3	Noise	Low	Low	Low	Low
	E.4	Wetlands/Water of the US	Med	Low	Low	Med
	E.5	Wildlife Habitats	Med	Med	Med	Low
	E.6	Cultural Resources	Low	Low	Low	Low
	E.7	Visual	Low	Low	Low	Low
Technical (Engin-eering)	T.1	Drainage and Hydrologic	Med	Low	Med	Med
	T.2	Electric Transmission Lines	Med	Med	Med	High
	T.3	Topography	Low	Low	Low	Low
	T.4	Proximity to Infrastructure	Low	Low	Low	Low
	T.5	Site Conditions	Med	Med	Low	Low
Consensus Evaluation of Constraint Level			Med	Low	Med	Med

Section 5
Environmental Water Quality

The purpose of the environmental water quality review was to assess receiving water quality impacts due to the introduction of Lake Palestine water under varying conditions into Lake Benbrook, Cedar Creek Reservoir, Richland-Chambers Reservoir, and Joe Pool Lake. The water quality review included data collection and analysis, mass balance calculations, and a water quality evaluation.

5.1 Data Collection and Analyses

Multiple sources, including the United States Army Corps of Engineers (USACE), TRWD, Trinity River Authority (TRA), Upper Neches River Municipal Water Authority, and the Texas Commission on Environmental Quality (TCEQ), were used to obtain daily historical reservoir storage and water quality data for this study. Reservoir volume data were analyzed for the following time periods in each of these reservoirs:

- Lake Benbrook: January 1980 - December 2007
- Cedar Creek Reservoir: January 1980 - December 2007
- Richland-Chambers Reservoir: January 1989 - December 2007
- Joe Pool Lake: January 1990 - September 2007.

Water quality data were collected and evaluated for each reservoir from January 1997 through December 2006 for alkalinity, dissolved iron, dissolved manganese, hardness, total dissolved solids, total organic carbon, pH, chlorophyll-A, dissolved oxygen, nitrite + nitrate, orthophosphate phosphorus, total phosphorus, secchi depth, and temperature.

Water quality data from TRWD's field-scale wetland system was collected and analyzed from June 2003 through March 2007. Because not all of the water quality parameters analyzed in the study reservoirs were available from TRWD's field-scale wetland system, this evaluation was limited to the following parameters: alkalinity, hardness, nitrite + nitrate, orthophosphate phosphorus, and total phosphorus.

For comparison purposes, the 2006 Region C Water Plan included an assessment of 5 key surface water quality parameters (ammonia nitrogen, nitrate nitrogen, total phosphorus, chlorophyll-a, and total dissolved solids) in its evaluation of water quality impacts for the recommended water management strategies based upon historical median concentrations of the parameters in the source and receiving waters.

5.2 Environmental Water Quality Mass Balance

As part of this water quality assessment, a water quality mass balance was performed to analyze the impact on water quality due to introducing Lake Palestine water into Lake Benbrook, Cedar Creek Reservoir, Richland-Chambers Reservoir, and/or Joe Pool Lake. The water quality parameters evaluated utilizing a mass balance approach include:

- Alkalinity
- Dissolved Iron
- Dissolved Manganese
- Hardness
- Total Dissolved Solids
- Total Organic Carbon
- Chlorophyll-A
- Dissolved Oxygen
- Nitrite + Nitrate
- Orthophosphate Phosphorus
- Total Phosphorus.

The mass balance calculation utilized the historical water quality conditions shown in **Table 5-1** with the introduction of 102 MGD of water from Lake Palestine over a 3 and 6 month period. Lake Palestine water was added to the receiving reservoir as a volume with a specified concentration. The volume of Lake Palestine water was calculated by multiplying 102 MGD by 90 days for the 3 month mass balance and by 180 days for the 6 month mass balance. Lake Palestine water was introduced under various reservoir volume conditions for Lake Benbrook, Cedar Creek Reservoir, Richland- Chambers Reservoir, and Joe Pool Lake. The destination reservoirs were evaluated at reservoir volume conditions equal to the 50th, 75th, and 90th percentile of historical volume and at 50%, 75%, and 90% of the conservation storage capacity. **Table 5-2**, through **Table 5-5** present the results of the calculated water quality concentrations of each parameter after the introduction of Lake Palestine water.

When available, water quality data from the main body of the reservoirs was utilized. Water quality data from TRWD's field-scale wetland system into Alligator Creek was also utilized for this analysis. Average water quality parameter concentrations were calculated for 3 and 6 month time periods from January 1997 through December 2006 for the reservoirs and from June 2003 through March 2007 for the wetland system. The 3 month averages include the months of July through September and the 6 month averages include the months of June through November. For each parameter in the reservoirs, the 3 and 6 month averages were developed by first averaging the concentrations of samples taken at different depths at the same location at the same time. Then, the concentrations for samples taken on the same date in the main pool of the reservoir were averaged to obtain an overall concentration for the reservoir on each sample date. Finally, the concentrations for dates that fell within the 3 and 6 month time period were averaged to acquire one concentration for each time period that would represent the overall average concentration in the main pool of the reservoir. The Alligator Creek data did not have multiple sampling locations, depths, or multiple samples per day; therefore, the wetland system data was simply averaged in 3 and 6 month time periods.

Table 5-1
Average Background Concentrations for Treatability and Nutrient Parameters

	Parameter	Time Period	Benbrook	Cedar Creek	Richland-Chambers	TRWD Wetland	Joe Pool	Palestine
Treatability Parameters	Alkalinity (mg/L)	3 Month	96.67	59.59	86.25	121.26	102.69	37.50
		6 Month	106.81	61.82	90.51	113.02	106.04	37.85
	Dissolved Iron (ug/L)	3 Month	22.78	26.14	33.91	---	67.74	110.00
		6 Month	22.58	78.73	40.53	---	59.02	110.00
	Dissolved Manganese (ug/L)	3 Month	28.17	132.43	35.64	---	103.77	250.00
		6 Month	24.73	82.61	30.62	---	90.48	250.00
	Hardness (mg/L)	3 Month	140.00	50.00	95.00	171.96	149.38	40.00
		6 Month	140.00	50.00	95.00	167.41	153.17	47.67
	Total Dissolved Solids (mg/L)	3 Month	181.47	130.46	153.48	---	318.88	138.60
		6 Month	189.17	131.71	159.36	---	312.55	138.41
	Total Organic Carbon (mg/L)	3 Month	5.18	6.94	5.39	---	4.05	8.63
		6 Month	5.25	6.91	5.41	---	4.76	8.50
	pH	3 Month	7.98	8.20	8.10	---	8.08	7.65
		6 Month	7.96	8.10	8.07	---	8.13	7.55
Nutrient Parameters	Chlorophyll-A (ug/L)	3 Month	31.57	34.07	21.10	---	6.85	42.83
		6 Month	26.63	30.21	20.98	---	6.85	39.39
	Dissolved Oxygen (mg/L)	3 Month	5.62	5.56	4.85	---	6.39	5.26
		6 Month	5.96	6.21	5.48	---	7.22	5.51
	Nitrite + Nitrate (mg/L)	3 Month	0.01	0.03	0.03	0.11	0.06	0.38
		6 Month	0.02	0.07	0.06	0.20	0.08	0.42
	Orthophosphate Phosphorus (mg/L)	3 Month	0.01	0.04	0.02	0.82	0.02	0.06
		6 Month	0.01	0.03	0.01	0.60	0.02	0.06
	Total Phosphorus (mg/L)	3 Month	0.08	0.11	0.08	0.81	0.03	0.08
		6 Month	0.07	0.10	0.08	0.61	0.06	0.10
	Secchi Depth (m)	3 Month	0.73	0.76	0.93	---	1.07	0.82
		6 Month	0.81	0.78	0.88	---	1.03	0.77
	Temperature (^{o}C)	3 Month	26.73	28.63	27.80	---	28.73	28.20
		6 Month	25.35	26.72	26.11	---	26.29	26.04

Table 5-2
Water Quality Concentrations in Lake Benbrook with the Inclusion of 102 MGD of Lake Palestine Water

					Benbrook Historical Volume by Percentile (acre-feet)			Benbrook Volume by Percentage of Conservation Storage (acre-feet)		
					50th	75th	90th	50%	75%	90%
					81,960	86,240	89,402	42,824	64,236	77,083
		Background Concentrations			Benbrook Parameter Concentrations after Blending 102 MGD of Lake Palestine Water					
	Parameter	Time Period	Benbrook	Palestine						
Treatability Parameters	Alkalinity (mg/L)	3 Month	96.67	37.50	81.29	81.86	82.26	72.88	78.36	80.58
		6 Month	106.81	37.85	78.44	79.29	79.88	67.35	74.30	77.41
	Dissolved Iron (ug/L)	3 Month	22.78	110.00	45.46	44.61	44.03	57.85	49.78	46.50
		6 Month	22.58	110.00	58.55	57.47	56.72	72.61	63.79	59.85
	Dissolved Manganese (ug/L)	3 Month	28.17	250.00	85.85	83.70	82.21	117.36	96.83	88.50
		6 Month	24.73	250.00	117.40	114.64	112.70	153.63	130.92	120.77
	Hardness (mg/L)	3 Month	140.00	40.00	114.00	114.97	115.64	99.79	109.05	112.80
		6 Month	140.00	47.67	102.01	103.15	103.94	87.16	96.47	100.64
	Total Dissolved Solids (mg/L)	3 Month	181.47	138.60	170.33	170.74	171.03	164.24	168.20	169.81
		6 Month	189.17	138.41	168.29	168.91	169.35	160.13	165.24	167.53
	Total Organic Carbon (mg/L)	3 Month	5.18	8.63	6.08	6.04	6.02	6.57	6.25	6.12
		6 Month	5.25	8.50	6.59	6.55	6.52	7.11	6.78	6.64
	pH	3 Month	7.98	7.65						
		6 Month	7.96	7.55						
Nutrient Parameters	Chlorophyll-A (ug/L)	3 Month	31.57	42.83	34.50	34.39	34.31	36.10	35.05	34.63
		6 Month	26.63	39.39	31.88	31.72	31.61	33.93	32.64	32.07
	Dissolved Oxygen (mg/L)	3 Month	5.62	5.26	5.53	5.53	5.54	5.48	5.51	5.53
		6 Month	5.96	5.51	5.78	5.78	5.78	5.70	5.75	5.77
	Nitrite + Nitrate (mg/L)	3 Month	0.01	0.38	0.11	0.11	0.10	0.16	0.13	0.11
		6 Month	0.02	0.42	0.19	0.18	0.18	0.25	0.21	0.19
	Orthophosphate Phosphorus (mg/L)	3 Month	0.01	0.06	0.02	0.02	0.02	0.03	0.02	0.02
		6 Month	0.01	0.06	0.03	0.03	0.03	0.04	0.03	0.03
	Total Phosphorus (mg/L)	3 Month	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
		6 Month	0.07	0.10	0.08	0.08	0.08	0.09	0.09	0.09
	Secchi Depth (m)	3 Month	0.73	0.82						
		6 Month	0.81	0.77						
	Temperature (°C)	3 Month	26.73	28.20						
		6 Month	25.35	26.04						

Table 5-3
Water Quality Concentrations in Cedar Creek Reservoir with the Inclusion of 102 MGD of Lake Palestine Water

					Cedar Creek Historical Volume by Percentile (acre-feet)			Cedar Creek Volume by Percentage of Conservation Storage (acre-feet)		
					50th	75th	90th	50%	75%	90%
					619,743	636,241	639,596	322,393	483,589	580,307
	Parameter	Background Concentrations			Cedar Creek Parameter Concentrations after Blending 102 MGD of Lake Palestine Water					
		Time Period	Cedar Creek	Palestine						
Treatability Parameters	Alkalinity (mg/L)	3 Month	59.59	37.50	58.60	58.63	58.63	57.77	58.34	58.54
		6 Month	61.82	37.85	59.80	59.84	59.85	58.21	59.29	59.67
	Dissolved Iron (ug/L)	3 Month	26.14	110.00	29.87	29.77	29.76	33.02	30.86	30.11
		6 Month	78.73	110.00	81.37	81.31	81.30	83.45	82.04	81.54
	Dissolved Manganese (ug/L)	3 Month	132.43	250.00	137.65	137.52	137.50	142.07	139.04	137.99
		6 Month	82.61	250.00	96.77	96.44	96.37	107.86	100.34	97.65
	Hardness (mg/L)	3 Month	50.00	40.00	49.56	49.57	49.57	49.18	49.44	49.53
		6 Month	50.00	47.67	49.80	49.81	49.81	49.65	49.75	49.79
	Total Dissolved Solids (mg/L)	3 Month	130.46	138.60	130.82	130.81	130.81	131.13	130.92	130.85
		6 Month	131.71	138.41	132.28	132.26	132.26	132.72	132.42	132.31
	Total Organic Carbon (mg/L)	3 Month	6.94	8.63	7.02	7.01	7.01	7.08	7.04	7.02
		6 Month	6.91	8.50	7.05	7.04	7.04	7.15	7.08	7.05
	pH	3 Month	8.20	7.65						
		6 Month	8.10	7.55						
Nutrient Parameters	Chlorophyll-A (ug/L)	3 Month	34.07	42.83	34.46	34.45	34.45	34.79	34.56	34.48
		6 Month	30.21	39.39	30.98	30.97	30.96	31.59	31.18	31.03
	Dissolved Oxygen (mg/L)	3 Month	5.56	5.26	5.55	5.55	5.55	5.54	5.55	5.55
		6 Month	6.21	5.51	6.15	6.15	6.15	6.11	6.14	6.15
	Nitrite + Nitrate (mg/L)	3 Month	0.03	0.38	0.05	0.05	0.05	0.06	0.05	0.05
		6 Month	0.07	0.42	0.10	0.10	0.10	0.12	0.11	0.10
	Orthophosphate Phosphorus (mg/L)	3 Month	0.04	0.06	0.04	0.04	0.04	0.04	0.04	0.04
		6 Month	0.03	0.06	0.04	0.04	0.04	0.04	0.04	0.04
	Total Phosphorus (mg/L)	3 Month	0.11	0.08	0.11	0.11	0.11	0.11	0.11	0.11
		6 Month	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
	Secchi Depth (m)	3 Month	0.76	0.82						
		6 Month	0.78	0.77						
	Temperature (°C)	3 Month	28.63	28.20						
		6 Month	26.72	26.04						

Table 5-4
Water Quality Concentrations in Richland-Chambers Reservoir with the Inclusion of 102 MGD of Lake Palestine Water

					Richland-Chambers Historical Volume by Percentile (acre-feet)			Richland-Chambers Volume by Percentage of Conservation Storage (acre-feet)		
					50th	75th	90th	50%	75%	90%
					1,110,070	1,138,876	1,154,625	568,300	852,450	1,022,940
	Parameter	Background Concentrations			Richland-Chambers Parameter Concentrations after Blending 102 MGD of Lake Palestine Water					
		Time Period	Richland - Chambers	Palestine						
Treatability Parameters	Alkalinity (mg/L)	3 Month	86.25	37.50	85.02	85.05	85.07	83.90	84.66	84.92
		6 Month	90.51	37.85	87.92	87.99	88.02	85.69	87.19	87.71
	Dissolved Iron (ug/L)	3 Month	33.91	110.00	35.84	35.79	35.76	37.58	36.40	36.00
		6 Month	40.53	110.00	43.94	43.85	43.81	46.89	44.90	44.21
	Dissolved Manganese (ug/L)	3 Month	35.64	250.00	41.06	40.93	40.86	45.98	42.65	41.51
		6 Month	30.62	250.00	41.38	41.12	40.99	50.71	44.43	42.25
	Hardness (mg/L)	3 Month	95.00	40.00	93.61	93.64	93.66	92.35	93.20	93.49
		6 Month	95.00	47.67	92.68	92.73	92.76	90.67	92.02	92.49
	Total Dissolved Solids (mg/L)	3 Month	153.48	138.60	153.11	153.12	153.12	152.77	153.00	153.08
		6 Month	159.36	138.41	158.33	158.36	158.37	157.44	158.04	158.25
	Total Organic Carbon (mg/L)	3 Month	5.39	8.63	5.48	5.47	5.47	5.55	5.50	5.48
		6 Month	5.41	8.50	5.57	5.56	5.56	5.70	5.61	5.58
	pH	3 Month	8.10	7.65						
		6 Month	8.07	7.55						
Nutrient Parameters	Chlorophyll-A (ug/L)	3 Month	21.10	42.83	21.65	21.64	21.63	22.15	21.81	21.69
		6 Month	20.98	39.39	21.89	21.86	21.85	22.67	22.14	21.96
	Dissolved Oxygen (mg/L)	3 Month	4.85	5.26	4.86	4.86	4.86	4.87	4.86	4.86
		6 Month	5.48	5.51	5.48	5.48	5.48	5.48	5.48	5.48
	Nitrite + Nitrate (mg/L)	3 Month	0.03	0.38	0.03	0.03	0.03	0.04	0.04	0.04
		6 Month	0.06	0.42	0.07	0.07	0.07	0.09	0.08	0.08
	Orthophosphate Phosphorus (mg/L)	3 Month	0.02	0.06	0.02	0.02	0.02	0.02	0.02	0.02
		6 Month	0.01	0.06	0.02	0.02	0.02	0.02	0.02	0.02
	Total Phosphorus (mg/L)	3 Month	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
		6 Month	0.08	0.10	0.08	0.08	0.08	0.08	0.08	0.08
	Secchi Depth (m)	3 Month	0.93	0.82						
		6 Month	0.88	0.77						
	Temperature (°C)	3 Month	27.80	28.20						
		6 Month	26.11	26.04						

Table 5-5
Water Quality Concentrations in Joe Pool Lake with the Inclusion of 102 MGD of Lake Palestine Water

					Joe Pool Historical Volume by Percentile (acre-feet)			Joe Pool Volume by Percentage of Conservation Storage (acre-feet)		
					50th	75th	90th	50%	75%	90%
					176,074	178,844	184,316	88,448	132,671	159,206
		Background Concentrations			Joe Pool Parameter Concentrations after Blending 102 MGD of Lake Palestine Water					
	Parameter	Time Period	Joe Pool	Palestine						
Treatability Parameters	Alkalinity (mg/L)	3 Month	102.69	37.50	93.53	93.65	93.88	86.68	91.07	92.71
		6 Month	106.04	37.85	89.30	89.50	89.87	79.24	85.48	88.00
	Dissolved Iron (ug/L)	3 Month	67.74	110.00	73.68	73.60	73.45	78.12	75.28	74.22
		6 Month	59.02	110.00	71.54	71.39	71.11	79.06	74.40	72.51
	Dissolved Manganese (ug/L)	3 Month	103.77	250.00	124.32	124.05	123.53	139.68	129.85	126.17
		6 Month	90.48	250.00	129.64	129.18	128.30	153.18	138.59	132.69
	Hardness (mg/L)	3 Month	149.38	40.00	134.00	134.21	134.60	122.51	129.87	132.62
		6 Month	153.17	47.67	127.27	127.57	128.15	111.70	121.35	125.25
	Total Dissolved Solids (mg/L)	3 Month	318.88	138.60	293.54	293.87	294.52	274.60	286.72	291.26
		6 Month	312.55	138.41	269.80	270.30	271.26	244.10	260.04	266.47
	Total Organic Carbon (mg/L)	3 Month	4.05	8.63	4.69	4.69	4.67	5.18	4.87	4.75
		6 Month	4.76	8.50	5.68	5.67	5.65	6.23	5.89	5.75
	pH	3 Month	8.08	7.65						
		6 Month	8.13	7.55						
Nutrient Parameters	Chlorophyll-A (ug/L)	3 Month	6.85	42.83	11.91	11.84	11.71	15.69	13.27	12.36
		6 Month	6.85	39.39	14.84	14.75	14.57	19.64	16.66	15.46
	Dissolved Oxygen (mg/L)	3 Month	6.39	5.26	6.23	6.23	6.23	6.11	6.19	6.21
		6 Month	7.22	5.51	6.80	6.80	6.81	6.55	6.70	6.77
	Nitrite + Nitrate (mg/L)	3 Month	0.06	0.38	0.10	0.10	0.10	0.14	0.12	0.11
		6 Month	0.08	0.42	0.16	0.16	0.16	0.21	0.18	0.17
	Orthophosphate Phosphorus (mg/L)	3 Month	0.02	0.06	0.02	0.02	0.02	0.03	0.02	0.02
		6 Month	0.02	0.06	0.03	0.03	0.03	0.03	0.03	0.03
	Total Phosphorus (mg/L)	3 Month	0.03	0.08	0.04	0.04	0.04	0.04	0.04	0.04
		6 Month	0.06	0.10	0.07	0.07	0.07	0.08	0.07	0.07
	Secchi Depth (m)	3 Month	1.07	0.82						
		6 Month	1.03	0.77						
	Temperature (°C)	3 Month	28.73	28.20						

Because water quality data were not available for the field-scale wetland system for all of the parameters included in this analysis, **Table 5-3** and **Table 5-4** do not include the addition of the future Cedar Creek and Richland-Chambers constructed wetland systems. A separate analysis of only the parameters available in the wetlands data was performed to show the addition of the wetland systems and the results are shown in **Table 5-6** and **Table 5-7**. Under CA 08-4976C, TRWD may divert 88,059 ac-ft/yr at a maximum rate of 156.6 cfs from the Cedar Creek wetland system to Cedar Creek Reservoir. Under CA 08-5035C, TRWD may divert 100,465 ac-ft/yr or a maximum of 11,398 ac-ft/month from the Richland-Chambers wetland system to Richland - Chambers Reservoir. The impact of including the Richland-Chambers and Cedar Creek wetland systems was evaluated at their maximum monthly diversion rate over a 3 and 6 month time period.

Table 5-6
Water Quality Concentrations in Cedar Creek Reservoir with Wetland Effluent and the Inclusion of 102 MGD of Lake Palestine Water

						Cedar Creek Historical Volume by Percentile (acre-feet)			Cedar Creek Volume by Percentage of Conservation Storage (acre-feet)		
						50th	75th	90th	50%	75%	90%
						619,743	636,241	639,596	322,393	483,589	580,307
	Parameter	Background Concentrations Time Period	Cedar Creek	Wetland	Palestine	Cedar Creek Parameter Concentrations after Blending Wetland Effluent and 102 MGD of Lake Palestine Water					
Treatability Parameters	Alkalinity (mg/L)	3 Month	59.59	121.26	37.50	61.25	61.21	61.20	62.55	61.67	61.35
		6 Month	61.82	113.02	37.85	63.92	63.87	63.86	65.35	64.40	64.04
	Dissolved Iron (ug/L)	3 Month	26.14	---	110.00						
		6 Month	78.73	---	110.00						
	Dissolved Manganese (ug/L)	3 Month	132.43	---	250.00						
		6 Month	82.61	---	250.00						
	Hardness (mg/L)	3 Month	50.00	171.96	40.00	54.72	54.61	54.59	58.42	55.91	55.01
		6 Month	50.00	167.41	47.67	58.91	58.72	58.68	64.98	60.94	59.42
	Total Dissolved Solids (mg/L)	3 Month	130.46	---	138.60						
		6 Month	131.71	---	138.41						
	Total Organic Carbon (mg/L)	3 Month	6.94	---	8.63						
		6 Month	6.91	---	8.50						
	pH	3 Month	8.20	---	7.65						
		6 Month	8.10	---	7.55						
Nutrient Parameters	Chlorophyll-A (ug/L)	3 Month	34.07	---	42.83						
		6 Month	30.21	---	39.39						
	Dissolved Oxygen (mg/L)	3 Month	5.56	---	5.26						
		6 Month	6.21	---	5.51						
	Nitrite + Nitrate (mg/L)	3 Month	0.03	0.11	0.38	0.05	0.05	0.05	0.06	0.05	0.05
		6 Month	0.07	0.20	0.42	0.11	0.11	0.11	0.13	0.12	0.11
	Orthophosphate Phosphorus (mg/L)	3 Month	0.04	0.82	0.06	0.08	0.08	0.08	0.10	0.08	0.08
		6 Month	0.03	0.60	0.06	0.08	0.08	0.08	0.11	0.09	0.08
	Total Phosphorus (mg/L)	3 Month	0.11	0.81	0.08	0.14	0.14	0.14	0.16	0.15	0.14
		6 Month	0.10	0.61	0.10	0.14	0.14	0.14	0.17	0.15	0.15
	Secchi Depth (m)	3 Month	0.76	---	0.82						
		6 Month	0.78	---	0.77						
	Temperature (°C)	3 Month	28.63	---	28.20						
		6 Month	26.72	---	26.04						

Table 5-7
Water Quality Concentrations in Richland-Chambers Reservoir with Wetland Effluent and the Inclusion of 102 MGD of Lake Palestine Water

						Richland-Chambers Volume by Percentile (acre-feet)			Richland-Chambers Volume by Percentage of Conservation Storage (acre-feet)		
						50th	75th	90th	50%	75%	90%
						1,110,070	1,138,876	1,154,625	568,300	852,450	1,022,940
		Background Concentrations				Richland-Chambers Parameter Concentrations after Blending Wetland Effluent and 102 MGD of Lake Palestine Water					
	Parameter	Time Period	Richland-Chambers	Wetland	Palestine						
Treatability Parameters	Alkalinity (mg/L)	3 Month	86.25	121.26	37.50	86.08	86.08	86.08	85.92	86.03	86.06
		6 Month	90.51	113.02	37.85	89.31	89.34	89.35	88.38	89.00	89.22
	Dissolved Iron (ug/L)	3 Month	33.91	---	110.00						
		6 Month	40.53	---	110.00						
	Dissolved Manganese (ug/L)	3 Month	35.64	---	250.00						
		6 Month	30.62	---	250.00						
	Hardness (mg/L)	3 Month	95.00	171.96	40.00	95.89	95.87	95.86	96.66	96.14	95.96
		6 Month	95.00	167.41	47.67	96.81	96.77	96.75	98.23	97.29	96.95
	Total Dissolved Solids (mg/L)	3 Month	153.48	---	138.60						
		6 Month	159.36	---	138.41						
	Total Organic Carbon (mg/L)	3 Month	5.39	---	8.63						
		6 Month	5.41	---	8.50						
	pH	3 Month	8.10	---	7.65						
		6 Month	8.07	---	7.55						
Nutrient Parameters	Chlorophyll-A (ug/L)	3 Month	21.10	---	42.83						
		6 Month	20.98	---	39.39						
	Dissolved Oxygen (mg/L)	3 Month	4.85	---	5.26						
		6 Month	5.48	---	5.51						
	Nitrite + Nitrate (mg/L)	3 Month	0.03	0.11	0.38	0.04	0.04	0.04	0.05	0.04	0.04
		6 Month	0.06	0.20	0.42	0.08	0.08	0.08	0.10	0.09	0.08
	Orthophosphate Phosphorus (mg/L)	3 Month	0.02	0.82	0.06	0.04	0.04	0.04	0.06	0.05	0.04
		6 Month	0.01	0.60	0.06	0.05	0.05	0.05	0.08	0.06	0.05
	Total Phosphorus (mg/L)	3 Month	0.08	0.81	0.08	0.11	0.10	0.10	0.12	0.11	0.11
		6 Month	0.08	0.61	0.10	0.11	0.11	0.11	0.13	0.12	0.11
Secchi Depth (m)		3 Month	0.93	---	0.82						
		6 Month	0.88	---	0.77						
Temperature (°C)		3 Month	27.80	---	28.20						
		6 Month	26.11	---	26.04						

5.3 Environmental Water Quality Evaluation Results

The impact on each receiving reservoir was evaluated under volume conditions equal to the 50th, 75th, and 90th percentile of historical volume and at 50%, 75%, and 90% of the conservation storage capacity. The historical water quality concentrations and calculated concentrations from the mass balance for the reservoirs and the wetland system were evaluated and the results are presented below.

As noted in the 2006 Region C Water Plan, in general, East Texas reservoirs such as Lake Palestine have higher concentrations of nutrients than the evaluated receiving reservoirs discussed below. The Region C Water Plan notes that all of the water management strategies involving importation of water from East Texas were considered to have "low" or "medium-low" impacts on key water quality parameters.

5.3.1 Lake Benbrook

Although not considered to be a highly probable operational scenario, directly blending 102 MGD of Lake Palestine water with Lake Benbrook would have the following impacts:

- An increase to dissolved iron, dissolved manganese, nitrite + nitrate, and orthophosphate phosphorus concentrations in Lake Benbrook;
- Lesser impact to alkalinity, total organic carbon, chlorophyll-A, and total phosphorus; and
- Improvement to hardness and total dissolved solids concentrations with the addition of Lake Palestine water.

5.3.2 Cedar Creek Reservoir

Blending 102 MGD of Lake Palestine water with Cedar Creek Reservoir would have the following impacts:

- An increase to the nitrite + nitrate concentration in Cedar Creek Reservoir;
- Lesser impact to alkalinity, dissolved iron, dissolved manganese, chlorophyll-A, and orthophosphate phosphorus; and
- Negligible impacts, both positive and negative, to hardness, total dissolved solids, total organic carbon, and total phosphorus.

With the inclusion of the wetland system and the blending of Lake Palestine water: nitrite + nitrate, orthophosphate phosphorus would increase from the historical concentration levels. Hardness would also increase from the historical concentration but to a lesser degree. Alkalinity will improve with the inclusion of the wetland system and the blending of Lake Palestine water.

5.3.3 Richland-Chambers Reservoir

Blending 102 MGD of Lake Palestine water with Richland-Chambers Reservoir would have the following impacts:

- An increase to the dissolved manganese and nitrite + nitrate concentration in Richland-Chambers Reservoir;
- Lesser negative impact to alkalinity, dissolved iron, total organic carbon, chlorophyll-A, and orthophosphate phosphorus;
- Improvement to the hardness in Richland-Chambers Reservoir with the addition of Lake Palestine water; and
- Negligible impacts, both positive and negative, to total dissolved solids and total phosphorus.

With the inclusion of the wetland system and the blending of Lake Palestine water nitrite + nitrate, orthophosphate phosphorus, and the total phosphorus would increase from the historical concentration. The negative impact to alkalinity and hardness from the historical concentration would be negligible with the inclusion of the wetland system and the blending of Lake Palestine water.

5.3.4 Joe Pool Lake

Blending 102 MGD of Lake Palestine water with Joe Pool Lake would:

- Increase dissolved manganese, chlorophyll-A, nitrite + nitrate, and orthophosphate phosphorus concentrations in Joe Pool Lake
- Negatively impact, though to a lesser extent, alkalinity, dissolved iron, total organic carbon, and total phosphorus; and
- Improve hardness and total dissolved solids concentrations with the addition of Lake Palestine water.

Section 6
Water Treatment Considerations

Blending TRWD and DWU raw water supplies would impact raw water quality and potentially the treatment requirements at water treatment plants that receive raw water from these entities. The purpose of this raw water treatment review and treatability analysis was to consider several potential scenarios of blending and transmission that would cause water quality changes that may require modifications to the existing water treatment plant processes.

The four project conveyance alternatives, described in **Table 1-1**, are reproduced below for the reader's convenience.

Alternative	Description
1 (Baseline)	Independent Systems: TRWD's East Texas Third Pipeline and DWU's connection of Lake Palestine to the proposed Southeast Water Treatment Plant
2 (Baseline)	Independent Systems: TRWD's East Texas Third Pipeline and DWU's connection of Lake Palestine to Joe Pool Lake
3 (Interconnection)	Integrated System: Interconnected Third Pipeline (upsized as compared to the baseline condition) with connection of Lake Palestine to Cedar Creek Reservoir and delivery to DWU at Joe Pool Lake and TRWD's customers through the Third Pipeline
4 (Interconnection)	Integrated System: Interconnected "Southern Pipeline" - Lake Palestine delivered to the Lake Benbrook area via a pipeline route to the south of the TRWD Third Pipeline route. Delivery to DWU at Joe Pool Lake and TRWD's customers through connections to the existing system and the Lake Benbrook pipeline.

In the two Baseline alternatives, TRWD would continue to provide raw water to its customer treatment facilities and DWU would deliver raw water to either the proposed Southeast Water Treatment Plant or to the Joe Pool Lake vicinity, for treatment nearby at a new water treatment plant or at the Dallas Bachman WTP. This is also the case for the two Interconnection alternatives with the exception that it was assumed DWU would deliver raw water only to the Joe Pool Lake area for treatment nearby at a new facility or at the Dallas Bachman WTP.

Due to the unlimited possible combinations of source water blends, this treatment evaluation confined the assumed blends to Lake Palestine water discharged solely into one of the four reservoirs: Richland-Chambers, Cedar Creek, Joe Pool or Benbrook. It was further assumed that water supplied from Richland-Chambers Reservoir and Cedar Creek Reservoir would be blended at a 2:1 ratio, similar to typical existing operations.

6.1 Water Quality Parameters of Concern

Raw water quality parameters that could impact treatment processes primarily include alkalinity, hardness, total organic carbon (TOC), total dissolved solids (TDS), bromide, iron, and manganese. The potential impacts of each of these parameters are discussed below.

Alkalinity. Alkalinity is a measure of water's ability to neutralize acid - its buffering capability. Waters with low alkalinity are typically more difficult to treat. Lower alkalinity waters will also require additional TOC reduction per the EPA Stage 1 Disinfectants/Disinfection Byproduct Rule (D/DBPR). Low alkalinity waters would also impact the design of, and materials used in, the transmission systems.

Hardness. Waters with high levels of hardness may require implementation of a softening process at the treatment plant. Such processes are more costly to construct and operate than conventional plants. For example, lime softening process produces significantly greater amounts of sludge that must be handled. Hardness levels are not a concern for any of the TRWD or DWU raw water supplies and were therefore assumed to not be an issue in this evaluation.

Total Organic Carbon. TOC levels have a direct impact on disinfection byproduct (DBP) formation. Raw water with a higher concentration of TOC will result in greater formation of regulated DBPs. Although TOC is not specifically regulated, a certain percentage of TOC reduction is required by the D/DBPR, and higher levels of raw water TOC require higher rates of TOC reduction.

Total Dissolved Solids. TDS is a measure of the concentration of minerals in the water. The Federal Secondary Standard for TDS is 500 mg/L and the TCEQ Secondary Standard is 1000 mg/L. Raw water supplies with TDS levels higher than the secondary standards would require higher-level treatment processes, such as reverse osmosis. TDS levels are not a problem for any of the TRWD or DWU raw water supplies and were not considered in this evaluation.

Bromide. Although Bromide is not a regulated parameter, its presence in raw water, can trigger a reaction with ozone to form bromate, a regulated compound. If the bromate concentration exceeds 10 ug/L, control techniques must be implemented, applied ozone dose reduced, or the ozonation process removed. Most of the WTPs that would be impacted by the interconnection of the raw water transmission system use ozonation as part of the treatment process.

Iron and Manganese. Iron and manganese are metals primarily associated with aesthetic water quality concerns, such as metallic tastes and staining of plumbing fixtures and laundry. Iron and manganese are regulated as secondary standards, with maximum levels of 0.3 mg/L and 0.05 mg/L respectively. Waters with higher levels of iron and manganese require removal, typically oxidation by aeration or with chlorine dioxide or permanganate. Ozone will also oxidize iron and manganese, but would typically not be added specifically for this purpose.

6.2 Reservoir Water Quality

Water quality parameters for the various reservoirs are summarized in Section 5. For purposes of this treatability analysis, the six month average water quality data between June and November were used. The reservoir water quality data are summarized below in **Table 6-1**.

Table 6-1
Reservoir Water Quality

Water Quality Parameter	Lake Palestine	Cedar Creek Reservoir	Richland-Chambers Reservoir	Lake Benbrook	Joe Pool Lake	Elm Fork Trinity River
Alkalinity (mg/L)	38	62	91	107	106	110
Hardness (mg/L)	48	50	95	140	153	140
TOC (mg/L)	8.5	6.9	5.4	5.3	4.8	5.0
TDS (mg/L)	138	132	159	189	313	N/A
Bromide (mg/L)	0.12	0.09	0.09	0.12	N/A	0.13
Iron (ug/L)	110	79	41	23	59	<100
Manganese (ug/L)	250	83	31	25	90	N/A

The Baseline and Interconnected water supply alternatives would result in changes to water quality that differ from the current raw water supplies provided to the TRWD customer water treatment plants and the DWU Bachman water treatment plant. This analysis used the blended water quality data presented in the Espey Consultants May, 2008 technical memorandum and used the **50th percentile reservoir volume** scenarios. A summary of water quality for each alternative is presented below.

6.3 DWU Water Treatment Considerations, Baseline Alternatives 1 and 2

The Baseline alternatives include taking raw water either directly from Lake Palestine to a new Southeast Water Treatment Plant (SEWTP) (Alternative 1), or taking Lake Palestine water to Joe Pool Lake for treatment at a new treatment plant nearby or at the Bachman WTP (Alternative 2). Therefore, in Baseline Alternative 1 water quality at the proposed SEWTP would be the same as Lake Palestine water quality. In Baseline Alternative 2, it was assumed that water would be taken from the pipeline prior to discharging into Joe Pool Lake. Therefore, water quality at a new treatment plant at Joe Pool Lake, or at the Bachman WTP, would be the same as Lake Palestine water.

Table 6-2 presents calculated water quality delivered to Dallas water treatment plants for these two Baseline alternatives and, for comparative purposes, the current raw water quality at the Bachman WTP.

Table 6-2
Water Quality with Implementation of DWU Baseline Alternative

Water Quality Parameter	SEWTP, New WTP near Joe Pool Lake, and Bachman WTP from Lake Palestine	Lake Palestine/Joe Pool Lake Blend (1)	Current Bachman Raw From Trinity River
Alkalinity (mg/L)	38	89	110
Hardness (mg/L)	48	127	140
TOC (mg/L)	8.5	5.7	5.0
TDS (mg/L)	138	270	
Bromide (mg/L)	0.12	–	0.13
Iron (ug/L)	110	72	<100
Manganese (ug/L)	250	130	

Note (1): The water quality blend illustrated in this column would only be applicable to a new water treatment plant near Joe Pool Lake or the Bachman WTP if a blend of Lake Palestine and Joe Pool Lake waters were used.

6.4 TRWD Water Treatment Considerations, Baseline Alternatives 1 and 2

For TRWD, Baseline Alternatives 1 and 2 include adding a Third Pipeline to carry raw water from Cedar Creek and Richland-Chambers Reservoirs (including water supply augmentation from the constructed wetlands) to its customers. TRWD would continue to use Lake Benbrook as terminal storage, primarily for the Fort Worth Rolling Hills WTP and future Westside WTP. Under the baseline alternatives, TRWD customers would not see a significant change in the water treatment parameters. **Table 6-3** presents potential water quality blends delivered to TRWD customer water treatment plants for the Baseline Alternatives 1 and 2. The Richland-Chambers/Cedar Creek blend was assumed to be a 2:1 blend ratio.

Table 6-3
Water Quality with Implementation of TRWD Baseline Alternative

Water Quality Parameter	Cedar Creek Reservoir	Richland-Chambers Reservoir	Cedar Creek/ Richland-Chambers Blend	Lake Benbrook
Alkalinity (mg/L)	62	91	81	107
Hardness (mg/L)	50	95	80	140
TOC (mg/L)	6.9	5.4	5.9	5.3
TDS (mg/L)	132	159	154	189
Bromide (mg/L)	0.09	0.09	0.09	0.12
Iron (ug/L)	79	41	54	23
Manganese (ug/L)	83	31	48	25

6.5 Interconnection Alternative 3 Water Treatment Considerations – Lake Palestine to Cedar Creek Reservoir

Under this Interconnection alternative, Lake Palestine water would be pumped to Cedar Creek Reservoir. The Lake Palestine/Cedar Creek blend may then be combined with Richland-Chambers water in the transmission system before delivery to TRWD customers and before delivery to DWU at Joe Pool Lake (for treatment nearby at a new WTP or at Bachman WTP). For this analysis, the raw water was assumed to be a 2:1 blend of water originating from Richland-Chambers Reservoir and Cedar Creek Reservoir (including Lake Palestine). **Table 6-4** presents potential water quality delivered through the interconnected system for this alternative.

Table 6-4
Water Quality with Delivery of Lake Palestine to Cedar Creek

Water Quality Parameter	Lake Palestine	Cedar Creek Reservoir	Lake Palestine/ Cedar Creek Blend	Richland-Chambers Reservoir	Cedar Creek/ Richland-Chambers Blend
Alkalinity (mg/L)	38	62	60	91	81
Hardness (mg/L)	48	50	50	95	80
TOC (mg/L)	8.5	6.9	7.0	5.4	5.9
TDS (mg/L)	138	132	132	159	150
Bromide (mg/L)	0.12	0.09	–	0.09	–
Iron (ug/L)	110	79	81	41	54
Manganese (ug/L)	250	83	97	31	53

6.6 Interconnection Alternative 4 Water Treatment Considerations – Lake Palestine to Lake Benbrook

Under this Interconnection alternative (the "southern pipeline"), Lake Palestine water could be pumped directly to the Lake Benbrook area bypassing Richland-Chambers and Cedar Creek during certain system operations. The Lake Palestine water could then be supplied to the Fort Worth Rolling Hills WTP and Westside WTP. Prior to reaching the Lake Benbrook area, Lake Palestine water could also supply the future Fort Worth Southwest WTP. All three of these plants could also be supplied from Cedar Creek Reservoir and Richland-Chambers Reservoir which would include blends of Lake Palestine and constructed wetlands waters. Other TRWD customers would continue to receive water directly from Richland-Chambers and Cedar Creek Reservoirs through the existing TRWD transmission pipelines.

Lake Palestine water from the southern pipeline would also be provided to the Joe Pool Lake area to supply the Bachman WTP or other new treatment facilities. The potential delivery of Lake Palestine water directly to the Lake Benbrook area is considered to be an infrequent possibility since it assumes the direct transfer of unblended Lake Palestine water to the outermost edge of the study area. Nevertheless, it provides the most extreme blending scenario in terms of water treatment considerations for an integrated system for some of the TRWD customers.

Table 6-5 presents potential water quality delivered through Interconnection Alternative 4 for this blending scenario. It also shows the water quality if Lake Palestine water were blended with Lake Benbrook water. Due to permitting and contract issues, this is not considered a likely scenario in the foreseeable future.

Table 6-5
Water Quality with Delivery of Lake Palestine to the Lake Benbrook Area

Water Quality Parameter	Fort Worth WTPs from Lake Palestine	Lake Benbrook	Lake Palestine/ Lake Benbrook Blend (1)
Alkalinity (mg/L)	38	107	78
Hardness (mg/L)	48	140	102
TOC (mg/L)	8.5	5.3	6.6
TDS (mg/L)	138	189	168
Bromide (mg/L)	0.12	0.12	–
Iron (ug/L)	110	23	59
Manganese (ug/L)	250	25	117

Note (1): For informational purposes. Not a likely scenario.

6.7 Treatability Issues

The Baseline and Integrated water supply alternatives present changes in raw water quality that will impact the treatment processes at the water treatment plants and could increase operational costs and potentially require additional capital expenditures. A discussion of the treatability issues for each project conveyance alternative follows.

6.7.1 Baseline Alternatives

Under Baseline Alternatives 1 and 2, WTPs currently receiving raw water from TRWD would continue to receive water delivered from Richland-Chambers Reservoir and Cedar Creek Reservoir, both of which would also include constructed wetlands augmentation in the future. The Fort Worth Rolling Hills WTP and future Westside WTP would also continue to receive water from Lake Benbrook under seasonal operational scenarios. No impact to water quality or treatability related to Lake Palestine would occur under this scenario.

Under Baseline Alternatives 1 and 2, either the proposed DWU Southeast WTP, new WTP near Joe Pool Lake, or the Bachman WTP would receive raw water directly from Lake Palestine. This water quality would be significantly different from the Elm Fork of the Trinity River raw water currently supplied to the Bachman WTP. The DWU WTPs could expect the following water quality and treatability issues under Alternatives 1 and 2:

- The raw water alkalinity would be less than 60 mg/L, limiting the raw water's buffering capability and making it more difficult to treat. The TOC would be above 8.0 mg/L, meaning that 50% of the TOC must be removed during the treatment process or an alternative minimum TOC removal requirement must be implemented. The proposed SEWTP could expect to use greater amounts of coagulant than those currently used at the Bachman WTP. Bench scale studies would be required to determine the actual amounts of coagulant required.

- The high levels of TOC raise the potential for high levels of disinfection byproduct (DBP) formation. If ozonation were to be used as the primary disinfectant (as at the Bachman WTP) and chloramine as the residual disinfectant, the plant should be able to control DBPs successfully.

- Iron levels from Lake Palestine water are somewhat elevated, but fall within the regulatory secondary standards. Plants utilizing ozone or chlorine dioxide would oxidize some of the iron, thereby reducing the iron content in the finished water.

- Manganese levels from Lake Palestine are well above the regulatory secondary drinking water standards. These manganese levels could be reduced to below the regulatory standards through oxidation with ozone, if it were applied similar to methods used at the Bachman WTP. However, care would be required to limit the potential for conversion of the manganese to permanganate, which could result in pink water. The use of biological filtration following the ozonation process has shown to be effective for manganese reduction. It is anticipated that approximately 0.25 mg/L of additional ozone dose would be required to provide the desired manganese oxidation. This would be in addition to the dosage required for disinfection and taste and odor control.

If under Baseline Alternative 2 the Lake Palestine water were pumped directly into Joe Pool Lake and then delivered to a new WTP near Joe Pool Lake or the Bachman WTP, the water quality parameters would be similar to current raw water quality from the Elm Fork of the Trinity River. This blending scenario was considered to provide insight into the impact of such a diversion.

- Raw water alkalinity of about 89 mg/L and TOC of 5.7 mg/L would require TOC reduction of 35%. This water would be more easily treated than the raw water directly from Lake Palestine.

- The TOC would be in line with current levels and should not present significant DBP formation issues, especially with the use of ozone and chloramine for disinfection.

- Manganese levels would still be elevated, although less than those associated with direct use of Lake Palestine water. The additional dose of ozone required for oxidation of manganese would be approximately 0.1 mg/L.

Treatability issues related to the Baseline alternatives would result in little impact to the TRWD customers, but would impact the DWU plants (and possibly any other water treatment plants using Joe Pool Lake in one alternative). Sending Lake Palestine raw water directly to the proposed Southeast WTP, Bachman WTP, or a new WTP near Joe Pool would have the greatest impact on the cost of operating the plant and meeting regulatory requirements.

6.7.2 Interconnection Alternative 3 / Water Treatment Scenario 1 – Lake Palestine to Cedar Creek Reservoir

Under this scenario, the blended Lake Palestine and Cedar Creek Reservoir raw water would be similar to the Cedar Creek raw water currently being provided to the TRWD customers. The only constituent of potential concern in this blend, related to water treatment, is manganese. However, as discussed above in the Baseline alternatives, oxidation with ozone would be an effective treatment process for reducing the manganese level. Minimal (if any) additional ozone would be required to oxidize the manganese. The Mansfield WTP does not use ozonation as part of its treatment process. However, it does use chlorine dioxide, which is at least as effective as ozone in oxidizing manganese.

Also under this scenario, the DWU Bachman WTP or new plant near Joe Pool Lake would be provided with the same water quality as the TRWD plants from the Third Pipeline. This water quality would be similar to the DWU Baseline Alternatives 1 and 2 discussed in Section 6.4, and the same water quality and treatment issues apply.

6.7.3 Interconnection Alternative 4 / Water Treatment Scenario 2 – Lake Palestine to Lake Benbrook

Under this worst case, low probability operational scenario, raw water from Lake Palestine would feed the Fort Worth Rolling Hills WTP and future Westside WTP. The Lake Palestine water would be similar to the more difficult Cedar Creek Reservoir water that the Rolling Hills WTP sometimes receives, except for the elevated iron and manganese levels. The treatability issues would be the same as those presented in the DWU Baseline alternative with low alkalinity, high TOC and elevated manganese levels. Additional coagulation chemicals would likely be required to treat this water. The ozonation process, in place at the Rolling Hills WTP, should oxidize the manganese for removal in the sedimentation and biological filtration processes of the plant. Under this scenario, the future Fort Worth Southwest WTP could also receive Lake Palestine raw water directly from the Southern Pipeline.

6.8 Summary and Conclusions

Integrating Lake Palestine water into the DWU and TRWD raw water supply systems would have a low to moderate impact on water quality and treatment at the existing and proposed water treatment plants. The major impacts of the Lake Palestine water relate to its low alkalinity, high TOC, and high manganese concentrations.

Implementing the Baseline alternatives would create no impact to water quality or treatability at the existing plants currently being served by TRWD since the supply sources would be the same (except for the planned implementation of the constructed wetlands project). The DWU Baseline alternative, with Lake Palestine water exclusively, would result in raw water at the proposed Southeast WTP, new WTP near Joe Pool Lake, or the Bachman WTP that is more difficult to treat when compared to the City's existing Bachman WTP. The low alkalinity would require greater amounts of coagulant for treatment. The higher TOC level would present more difficulty in meeting DBP requirements. The low alkalinity coupled with the relatively high TOC would require greater TOC reduction and most likely greater coagulant use. The high manganese levels would require greater, although not significant, ozone use for oxidation and removal of manganese. Although the Lake Palestine water is anticipated to be more difficult to treat, the overall treatment process could be similar to the current DWU plants, like Bachman WTP. The operational costs would be slightly greater due to increased ozone and coagulant requirements.

Implementing water quality scenario 1 in Interconnection Alternative 3 (described in Section 6.7.2) presents no major water quality issues that would adversely impact treatability or require significant increases in operational costs. The only constituent of concern is manganese, and it could be mitigated either through blending controls or oxidized through the current plant treatment processes.

The less probable water quality scenario 2 in Interconnection Alternative 4 (described in Section 6.7.3) results in the least favorable water quality for TRWD customer plants and presents the most treatability concerns of the integrated water quality scenarios and is provided as a "worst" case. The Fort Worth Rolling Hills and Westside WTPs could seasonally be provided with water with low alkalinity, high TOC, and relatively high manganese levels. Although the ozonation processes at both plants would oxidize the manganese, it would require closer management to effectively monitor and control the process and would result in greater costs for operation. This water quality scenario also could provide the proposed Fort Worth Southwest WTP with Lake Palestine raw water.

Section 7
Permitting and Regulatory Review

7.1 Introduction

This section presents a summary of the water rights and regulatory considerations for the various facilities considered in this Project Viability Assessment and as such represents a "fatal flaw" and due diligence review for this conceptual analysis.

7.2 Water Rights

7.2.1 Lake Palestine

- The Lake Palestine water right fully authorizes the interbasin transfer of up to a total of 132,337 ac-ft/yr from the Neches River Basin into the Trinity River Basin for municipal and industrial use, with no restrictions on where the water can be used or by whom.

- Any water diverted to the Trinity River Basin from the 18,000 ac-ft/yr of industrial water that is authorized for diversion from the Downstream Diversion Reservoir under the Lake Palestine water right that is not consumed must be returned "to an unnamed tributary of Cedar Creek, tributary of Trinity River" to one of two locations specified in Paragraph 7 of the Certificate of Adjudication. This means that most, if not all, of the diversions to the Trinity River Basin under the Lake Palestine water right should come from Lake Palestine.

- The maximum diversion rate for diversions from Lake Palestine is 518 cfs, which may limit how much water can be diverted to the Trinity River Basin when considered with other diversions that are made from the reservoir for other water users and customers of the Upper Neches River Municipal Water Authority.

- The priority dates for the interbasin transfer of water from Lake Palestine to the Trinity River Basin are relatively junior (1972 and 1983), compared to the primary priority date for impounding and using water in Lake Palestine (1956).

- None of the existing reservoirs in the Trinity River Basin being considered as potential terminal storage reservoirs for the Lake Palestine water are currently authorized for such storage, including Cedar Creek Reservoir, Richland-Chambers Reservoir, Lake Benbrook, Eagle Mountain Lake, and Joe Pool Lake.

- Lake Benbrook on the Trinity River Clear Fork and Eagle Mountain Lake on the Trinity River West Fork are authorized to store water delivered from Cedar Creek and Richland-Chambers Reservoirs.

- New water rights permits or amendments to existing reservoir water rights in the Trinity River Basin will be required to authorize the storage and use of Lake Palestine water by the City of Dallas and the Tarrant Regional Water District.

- The use of Joe Pool Lake for terminal storage of the Lake Palestine water will require contractual agreements with the U. S. Army Corps of Engineers (reservoir owner) and the Trinity River Authority (water right owner).

- The use of natural stream courses for conveying Lake Palestine water to storage reservoirs or end users in the Trinity River Basin will require "bed and banks" permits from the Texas Commission on Environmental Quality.

- Authorization for the indirect reuse of return flows from the use of Lake Palestine water for municipal or industrial purposes will need to be included in water rights permits associated with the Project.

7.2.2 Cedar Creek Reservoir

- Cedar Creek Reservoir is authorized to receive water from the TRWD constructed wetlands project. This indirect reuse project to naturally treat wastewater return flows is expected to add 52,500 acre-feet per year to the reservoir.

7.2.3 Richland-Chambers Reservoir

- Richland-Chambers Reservoir is authorized to receive water from TRWD constructed wetlands like Cedar creek Reservoir, adding 63,000 acre-feet per year to Richland-Chambers.

7.2.4 Lake Arlington

- The amended certificate of adjudication (CA) for Lake Arlington indicates that the co-owners of Lake Arlington are the City of Arlington and Texas Utilities Electric Company. It is our understanding that the CA has been assigned from TXU US Holdings Company to ExTex LaPorte. Current ownership of the CA and the reservoir may therefore be different than indicated on the CA.

7.2.5 Lake Benbrook

- Lake Benbrook is owned by the U.S. Army Corps of Engineers and the CA is owned by TRWD which has contracted with the Corps for water supply storage. Using Lake Benbrook for terminal storage of Lake Palestine water will require approval and arrangements between the two parties. This agreement may require federal approval pursuant to the Water Supply Act.

7.2.6 Joe Pool Lake

- Joe Pool Lake is owned by the U.S. Army Corps of Engineers and the CA is owned by the Trinity River Authority. Using Joe Pool Lake for terminal storage of Lake Palestine water will require approval and arrangements between the two parties and may federal approval pursuant to the Water Supply Act. The City of Grand Prairie, City of Duncanville, Midlothian Water District, and City of Cedar Hill have contractual rights to water from Joe Pool Lake.

- **Contract/Contractual Permit/Agreement 1421**. Owned by the City of Grand Prairie. Allows diversions of 1,795 af per year for municipal and domestic uses. Issue date May 22, 1984 and priority date June 15, 1977**.**

- **Contract/Contractual Permit/Agreement 1422**. Owned by the City of Duncanville. Allows diversions of 1,197 af per year for municipal and domestic uses. Issue date May 22, 1984 and priority date June 15, 1977.

- **Contract/Contractual Permit/Agreement 1423**. Owned by the Midlothian Water District. Allows diversions of 6,662 af per year for municipal and domestic uses. Issue date May 22, 1984 and priority date June 15, 1977.

- **Contract/Contractual Permit/Agreement 1424**. Owned by the City of Cedar Hill. Allows diversions of 7,346 af per year for municipal and domestic and industrial uses. Issue date May 22, 1984 and priority date June 15, 1977.

7.3 Federal Permits

- The construction of pumping and conveyance facilities and regulating reservoirs required for delivering Lake Palestine water to the Trinity River Basin users will require a permit(s) under Section 404 of the Clean Water Act to the extent that the discharge of dredged and fill material adversely impacts United States' waters.

- The required Section 404 permit(s) may be "individual" permit(s) tailored specifically for the facilities and impacts associated with the Project or they may be "general" or "nationwide" permits provided the Project facilities and associated impacts qualify.

- Potentially available nationwide permits:

    1. No. 12 – Utility Line Construction impacting less than one-half acre of United States' water.

    2. No. 18 – Minor Discharges of Dredged or Fill Material involving less than 25 cubic yards of material and impacting less than one-tenth acre of United States' waters.

- Pipeline crossings of navigable streams as part of the Project will require a permit(s) under Section 10 of the River and Harbors Act of 1899.

- The Trinity River in the vicinity of where Project pipelines potentially would cross is classified as being navigable by the Corps of Engineers.

7.4 Application of Section 402 of the Clean Water Act to the Transfer

Section 402 of the Clean Water Act authorizes the NPDES ("National Pollutant Discharge Elimination System"). The NPDES permit program regulates point sources

of pollutant discharges into the waters of the United States. Whether transfers of water such as the envisioned interbasin transfers should be subject to Section 402 has been the subject of extensive litigation. The U.S. Supreme Court addressed this question in 2004 and found that current law requires an NPDES merely for the conveyance of a pollutant from one hydrologically distinct basin to another. *South Florida Water Management Dist. V. Miccosukee Tribe of Indians, 541 U.S. 95 (2204).* More recently, the Second Circuit Court of Appeals found that NPDES permits are required for interbasin transfers. *Catskill Mountains Chapter of Trout Unlimited, Inc. v. City of New York,* 451 F.3d 77 (2nd Cir. 2006)

The EPA subsequently proposed an amendment to the Clean Water Act regulations on June 9, 2006 that would expressly exclude water transfers (including interbasin water transfers) from regulation under the NPDES program. The EPA adopted the final rule declaring that routine transfers of water from one water body to another are not subject to NPDES permitting requirements this June 9, 2008. This rule defines a routine transfer as an activity that conveys waters without subjecting the water to intervening industrial, municipal, or commercial use. The water transfer rule codifies the former EPA interpretation that permits are not required for transfers such as routing water through tunnels, channels, or natural stream courses for public supplies, irrigation, power generation, flood control and environmental restoration. Pollutants introduced by the water transfer activity itself to the water being transferred would still be subject to permitting under the new rule.

The final rule is effective 60 days after it is published in the Federal Register, which is anticipated will be quite soon. If the rule is finalized in its present form, we do not believe a NPDES permit will be required from the Texas Commission on Environmental Quality for the transfer.

7.5 State Permits

Several state permits or agency approvals may be necessary either in conjunction with publicly-funded, or even with privately-funded, project financial sources. Publicly-funded projects often require agency coordination with key federal, state, and regional agencies. This agency coordination is usually performed in conjunction with the National Environmental Policy Act of 1969 (NEPA) and requires coordination with federal agencies and also the key state agencies introduced below. Even those projects that will not seek federal funding may also be impacted by some of the entities listed below, such as projects occurring near impaired water bodies or possibly by other means, as are described below.

- The Texas Commission on Environmental Quality (TCEQ) permitting could impact any project location if it is not adequately pre-screened through Phase I Environmental Site Assessment (ESA) investigation to verify that no contaminated air, water, or waste media are known to exist as recognized environmental conditions at a proposed site. For instance, Total Maximum Daily Load (TMDL) considerations need to be evaluated with respect to known TMDL waterways and also for those potential TMDL stream segments that are soon to be designated and

implemented, in some cases for additional parameters.

Segment 0805 Upper Trinity River, the segment that encompasses the Trinity River from near the confluence of the Elm Fork Trinity River in western Dallas County down to Cedar Creek Reservoir, is classified as impaired by PCBs (bio-accumulated in fish tissue). Segment 0805 is also under recent consideration for a potential bacterial TMDL. Some of the lakes listed above, like Joe Pool Lake and Cedar Creek Reservoir, could be affected by such regulatory action and this needs to be evaluated before any final sites are determined for an inter-basin transfer from Lake Palestine.

Segments 0805 and 0841 (Trinity River) in Dallas and Tarrant Counties are also under the TMDL project for legacy pollutants (such as chlordane, DDT, DDE, dieldrin, heptachlor epoxide, and PCBs in fish tissue) that is under implementation for the Trinity River and the Mountain Creek Lake.

- Texas Historical Commission (THC) is the home to the Texas State Preservation Office (TSPO) that is located in the Capitol Complex north of the Texas Capitol building. The THC is tasked with to preserve the historical, archaeological, architectural, and cultural resources that are protected by state and federal antiquities laws. Federally-funded and even state-funded projects will normally require that the study of proposed sites have a Phase I pedestrian archaeological investigation. At a minimum, proposed sites should have a desktop study of the THC website, to see if any listings are registered for a site or in its direct proximity.

- Texas Parks and Wildlife Department (TPWD) is the state agency that is committed to the preservation and protection of the state's floral and faunal species, in conjunction with the US Fish and Wildlife Service (USFWS). As such, TPWD typically agrees with the lead taken by USFWS for animal species; however, they take the lead for the protection of any protected plant species that might be impacted by the proposed project.

- Texas Water Development Board (TWDB) is the agency that manages the state's regional water planning program. Dallas Water Utilities and Tarrant Regional Water District are both located in Region C, the North Central Texas planning region. Lake Palestine is situated in Region I, the East Texas regional water planning group. Coordination between these Regional Water Planning groups has identified the potential inter-basin transfer of Lake Palestine water from Region I to Region C to satisfy the needs of the Dallas-Fort Worth metropolitan region as early as the Texas Water Plan 2002.

7.6 State Draft Nutrient Regulation

The Texas Commission on Environmental Quality (TCEQ) in conjunction with the U.S. Geological Service (USGS) is currently evaluating options for developing nutrient criteria for consideration by the U.S. Environmental Protection Agency (EPA) and the public during the next triennial revision of the Texas Surface Water Quality Standards (Chapter 307 in Title 30 of the Texas Administrative Code). Texas has no such numerical criteria currently but does address nutrient loadings by applying narrative criteria for permitted discharges by developing watershed rules which require nutrient reductions in wastewater discharges in or near specified water bodies, and by employing TCEQ's anti-degradation policy to increases in discharge loads of nutrients.

For assessing water bodies and regulatory actions, the TCEQ is also evaluating a "weight of evidence" approach to incorporate historical monitoring data for total phosphorous and total nitrogen for individual water bodies. The evaluation of permitted discharges could be based on screening criteria developed from historical data of all of these variables, in addition to the criteria listed in the water quality standard, such as chlorophyll *a*.

TCEQ has formed and is working with a Nutrient Criteria Development Workgroup in order to obtain stakeholder input from state and federal agencies, Texas river authorities, cities, industry, environmental groups, agricultural and other interested parties. Reservoirs have been the TCEQ staff's initial priority. Draft numerical nutrient criteria for the supply and receiving reservoirs considered in this initial viability assessment, as well as for lakes across the state, were provided to the Texas Surface Water Quality Standards Workgroup at their May 5, 2008 meeting.

Procedures to assess standards compliance with monitoring data will be established in both Section 307.9 of the *Texas Surface Water Quality Standards* and the *TCEQ Guidance for Screening and Assessing* Texas Surface Water and Finished Drinking Water Quality Data. Procedures to assess and set loading limits on nitrogen and phosphorus from regulated sources, such as permitted wastewater discharges, will be established in the TCEQ Procedures to Implement the Texas Surface Water Quality Standards.

While these nutrient regulations are still in the draft stages with TCEQ and do not currently apply to the inter-basin transfer of Lake Palestine water to the reservoirs evaluated in this study, all water supply agencies should be closely monitoring this developing regulatory program. Subsequent studies of the efficacy of an integrated raw water transmission system approach between TRWD and DWU will address this developing regulatory program.

Section 8
Dallas Water Utilities Additional Treatment and Water Transmission Facilities

8.1 Introduction

The purpose of this portion of the study was to consider additional cost and treatment implications for transmission of raw water to DWU treatment and distribution system facilities from project conveyance Alternatives 1 and 3, which respectively represent the independent and interconnected raw water transmission system (see **Table 1-1** for a full description of these alternatives). These additional treatment and water transmission facilities that may be required for a fully functional integrated strategy for DWU were beyond the initial study boundary (see **Figure 1-3**); therefore, costs implications in this section are additive to the DWU project conveyance alternative costs. These costs do not include distribution system improvements needed downstream of the water treatment plants. This study of three additional treatment and transmission scenarios (see **Table 8-1**) was guided by the following objectives:

1. Document the criteria that will be used in subsequent phases to select the preferred treatment/transmission scenarios and develop a listing of the applicable constraints to these scenarios (e.g. water quality, cost, and permitting complexity).

2. Develop transmission alternatives and treatment modification costs for **Scenario 1: water delivered to or around Joe Pool Lake and conveyed to the existing Bachman Water Treatment Plant (WTP).** Planning-level treatment modifications at the existing Bachman WTP to treat the water from an integrated raw water system were also considered.

3. Develop treatment costs for **Scenario 2**: **water delivered to, and treated at, the proposed Southeast WTP (SE WTP).** In this scenario, raw water would not be conveyed to or stored in Joe Pool Lake and would instead be delivered directly to the SE WTP from the integrated raw watery transmission system. Transmission costs were not included in this scenario because they were included in Interconnection Alternative 3. Treatment costs were based on construction of the new WTP.

4. Develop treatment costs for **Scenario 3**: **a new WTP located near Joe Pool Lake.** Transmission costs were not included in this scenario because they were included in Interconnection Alternatives 3 and 4. Treatment costs were based upon construction of a new WTP near Joe Pool Lake.

Table 8-1
DWU Additional Treatment and Transmission Facilities Scenarios

DWU Scenario	Conveyance	Treatment	Project Conveyance Alternative[1]
1 Bachman WTP	Delivery to or around Joe Pool Lake and conveyance to Bachman WTP	Possible Bachman WTP Process Modifications; Elm Fork Expansion	3 (Interconnected)
2 Southeast WTP	Conveyance included in Raw Water System Integration costs	New Southeast WTP	1 (Baseline)
3 WTP at Joe Pool	Conveyance included in Raw Water System Integration costs	New Joe Pool Lake WTP	3 (Interconnected)

8.2 Evaluation Criteria

In this section, evaluation criteria relate to the selection of a preferred route for transmission of water to the Bachman WTP and the estimation of costs (both capital and life-cycle) for transmission, new water treatment plants, and modifications or expansions to existing plants. This section describes criteria specific to this analysis and any differences between these criteria and those employed in other analyses in this report.

8.2.1 Transmission Infrastructure

A preliminary facility siting constraints analysis is described in Section 4 of this report to identify potential fatal flaws to locating water transmission facilities along select pipeline corridors and to make a comparison between project conveyance alternatives. Though this same level of data collection and analysis was not applied to the transmission routes to Bachman WTP, the criteria used in subsequent phases for the selection of preferred transmission scenarios, and a listing of the applicable constraints to these scenarios.

Transmission routes for this analysis were developed using limited data collection, including aerial photography, institutional knowledge, topography, and data collected for other tasks in this study. Based on this information, a preferred route was selected for cost evaluation. The basis for the capital and life-cycle cost evaluation is the same as described in Section 3 of this report (as applied to the four project conveyance alternatives for the raw water transmission system). The discount rates and cost of debt used in this life-cycle cost analysis correlate (as shown in **Table 8-1**) with the Project Conveyance Alternative discount rates and costs of debt. For example, the DWU baseline alternative rate of 4.58% was used in Scenario 2 and a

[1] Costs for Scenarios 1 through 3 are additive to the Project Conveyance Alternatives. Cost implications to Project Conveyance Alternatives 2 and 4 are not considered separately here because they fall within the bounds of these results.

discount rate of 4.77% was used for Scenarios 1 and 3 to correlate with Project Conveyance Alternative 3.

8.2.2 Water Treatment

Water treatment plant (WTP) construction and operating costs for the three DWU additional treatment and transmission facilities scenarios were based on the following:

- Raw water quality data (developed in Sections 5 and 6);
- Treatment process scenarios developed for the projected raw water quality;
- Recent construction costs for plants with similar processes on a cost per gallon basis;
- Water treatment costs (chemicals and power) associated with treatment only from similar plants treating similar waters;
- Plant capacity of 102 mgd; and
- Operating costs on a cost per gallon basis.

The treatment process selected for comparing the three DWU additional treatment and transmission facilities scenarios is similar to the Bachman WTP process and other current treatment plants served by TRWD. The treatment process includes the following processes:

- Raw water ozonation for primary disinfection, taste and odor control, and iron and manganese oxidation;
- Conventional treatment processes of rapid mix, flocculation, and sedimentation, using ferric sulfate coagulant with coagulant aid polymer;
- Biological filtration for turbidity reduction and assimilable organic carbon (AOC) removal for biological stability;
- Chloramines for residual disinfection;
- Clearwell storage;
- Lime or caustic for pH adjustment;
- Fluosilicic acid for fluoride addition; and
- Sludge lagoons for sludge handling

.

8.3 Scenario 1 – Bachman WTP

In this analysis, Scenario 1 correlates to the cost and water quality analysis found in Project Conveyance Alternative 3 (Interconnected Third Pipeline). Costs from this scenario are additive to Alternative 3 costs and the raw water used in this scenario is the same as that in Alternative 3, a blend of Lake Palestine and Cedar Creek Reservoir water.

8.3.1 Conveyance Alternative Routes in Scenario 1

Using limited data collection, including aerial photography, institutional knowledge, topography, and data collected for other tasks in this study, five feasible transmission routes were developed to deliver water from the integrated raw water transmission system pipelines to the Bachman WTP. These alternatives (all within Scenario 1) included, closed conduit and open channel pathways, delivery to and delivery around Joe Pool Lake, and conveyance through or around Mountain Creek Reservoir. The assumed take-point from the integrated raw water transmission system was from the approximate confluence of Joe Pool Lake and the Third Pipeline (or existing two pipelines) that delivers water from Cedar Creek and Richland-Chambers Reservoirs to Lake Benbrook.

Ground elevation profiles were developed for the five alternative routes to Bachman WTP using USGS contour information. **Figure 8-1** compares centerline ground elevations of each alternative route in Scenario 1. Each alternative route terminates at the same location (Bachman WTP) but differs in the intake location:

- Alternative route A intake is at the downstream end of Joe Pool Lake;
- Alternative route B intake is at a location downstream of Mountain Creek Lake (upstream of this point it is open channel flow);
- Alternative route C flows through Joe Pool Lake and then by gravity to the Trinity River where, after mixing with Trinity River flow, it is pumped to Bachman WTP;
- The intake location of alternative route D is from the Third Pipeline (or existing pipelines from Richland-Chambers and Cedar Creek Reservoirs) on the southwest side of Joe Pool Lake; and
- The intake location for alternative route E is from the Third Pipeline (or existing pipelines from Richland-Chambers and Cedar Creek Reservoirs) on the southeast side of Joe Pool Lake.

Alternative route D traverses the longest distance from the TRWD pipelines interconnection to the Bachman WTP. In **Figure 8-1,** station 0+00 represents the intake location of this longest alternative route and station 1600+00 represents the end location at the Bachman WTP intake. The pipeline profile was taken into consideration for the comparative analysis of the five alternative routes.

Table 8-2 provides some of the considerations used to develop the five alternative routes in Scenario 1. A schematic alignment of each alternative is provided in **Figure 8-2** through **Figure 8-6**. A more complete explanation of some of the "Advantages" and "Disadvantages" listed in **Table 8-2** is given here:

- The conservation pool of Joe Pool Lake is controlled by the U.S. Army Corps of Engineers in conjunction with the Trinity River Authority (TRA), which has contracted to several local customers. At this time, no storage is available to DWU for Lake Palestine water. Conveying water through Joe Pool Lake therefore has associated permitting, storage and operational issues that will require resolution should this alternative be selected.

- The general assumption in **Table 8-2** is that mixing Lake Palestine water with the Trinity River would degrade the Lake Palestine water quality.

- Alternative E – "TRWD Pipelines to Bachman WTP - SH 360 Alternative" assumes that the SH 360 corridor has available right-of-way to accommodate a pipeline. In March 2008, the North Texas Tollway Authority met with representatives from Texas Department of Transportation's Dallas and Fort Worth districts and the North Central Texas Council of Governments (NCTCOG) to discuss agency partnering and corridor planning for SH 360. The parties agreed to meet regularly to discuss scope and agency responsibilities. A description from www.nctog.org/trans/corridor/studies.asp reads: "The recommended improvements to the SH 360 South Corridor extend from Sublett Road/Camp Wisdom Road to the proposed Dallas-Fort Worth Regional Outer Loop south of US 287, passing through the cities of Arlington, Grand Prairie, and Mansfield. From Sublett Road/Camp Wisdom Road to Debbie Lane, SH 360 is planned to include 8 general purpose toll lanes; between Debbie Lane and the Dallas-Fort Worth Regional Outer Loop, 6 general purpose toll lanes are planned. In addition, the entire corridor will include 4 continuous frontage road lanes. The improvements from Sublett Road/Camp Wisdom Road to US 287 are expected to be completed by 2015, and the improvements from US 287 to the Dallas-Fort Worth Regional Outer Loop are expected to be completed by 2025."

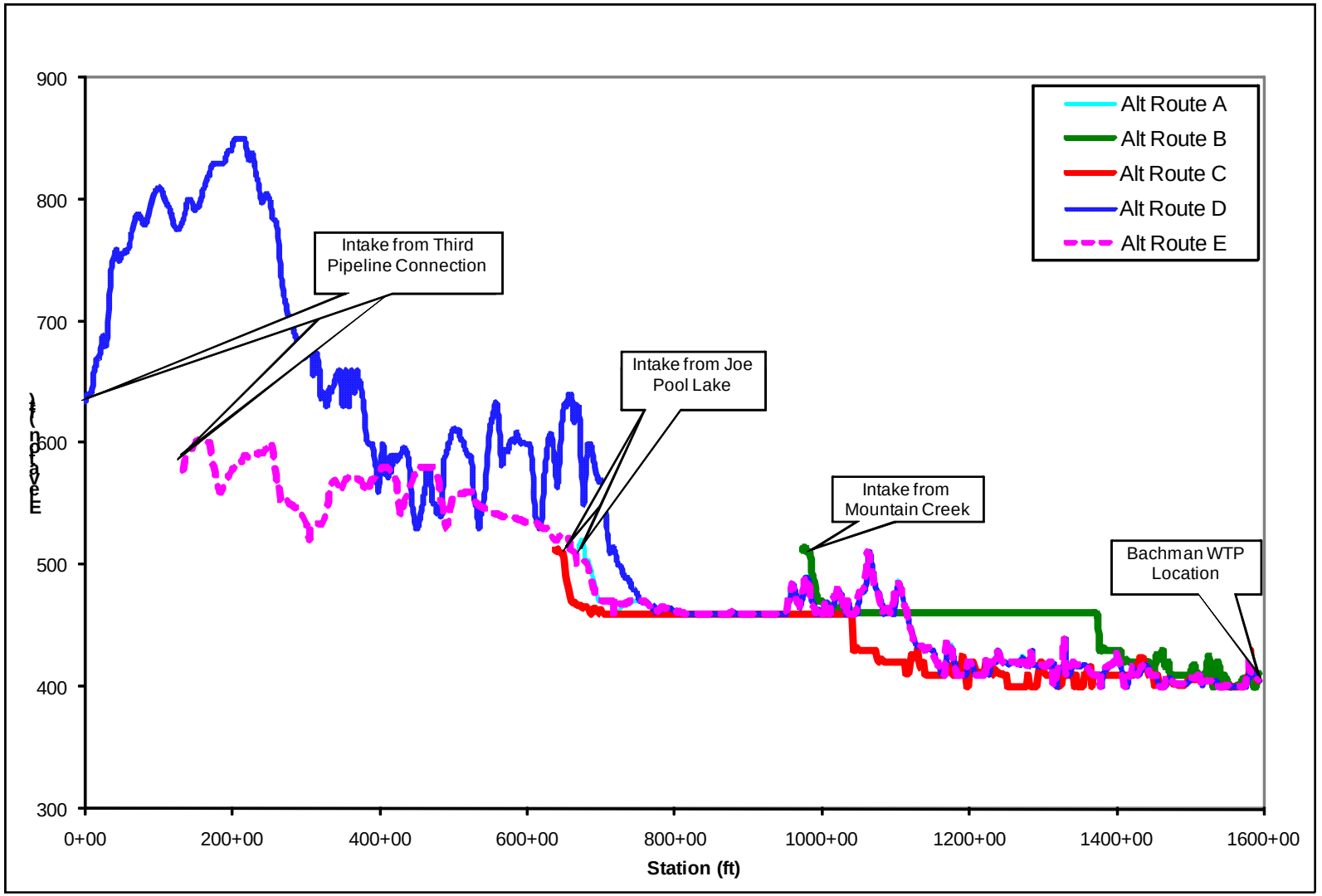


Figure 8-1
Profiles of Scenario 1 Alternative Conveyance Routes to Bachman WTP

Table 8-2
Scenario 1 Alternatives Conveyance Routes

Alternative Route	Description	Type	Pumped Flow Length (ft)	Channel Flow Length (ft)	Advantages	Disadvantages
A	Joe Pool Lake to Bachman WTP	Pumped flow	92,770 (17.6 mi)	0	Avoid potential water quality issues in the Trinity River	High pipeline and operational costs
						Joe Pool Lake permitting/storage issues
						Requires an intake facility at Joe Pool Lake
B	Joe Pool Lake to Bachman WTP	Open channel / Pumped flow	30,192 (5.7 mi)	62,294 (11.8 mi)	Potential cost benefit from reduced pipeline length	Joe Pool Lake permitting/storage issues
						Requires an intake facility on Mountain Creek
C	Joe Pool Lake to Bachman WTP	Open channel /Pumped flow	20,693 (3.9 mi)	75,192 (14.2 mi)	Potential cost benefit from reduced pipeline length	Potential water quality degradation due to Trinity River
						Joe Pool Lake permitting/storage issues
						Requires an intake facility on the Trinity River
D	Third Pipeline to Bachman WTP - Cedar Hill Alternative	Pumped flow	160,075 (30.3 mi)	0	Avoid potential water quality issues in the Trinity River	Highest pipeline and operational costs
					Avoid Joe Pool Lake permitting/storage issues	Permitting issues - pipeline corridor passes through federal & protected park lands
					Eliminate need for additional intake facility	Difficulty of obtaining easements because of urban setting
E	Third Pipeline to Bachman WTP - SH 360 Alternative	Pumped flow	146,669 (27.8 mi)	0	Avoid potential water quality issues in the Trinity River	Higher pipeline and operational costs
					Avoid Joe Pool Lake permitting/storage issues	
					Eliminate need for additional intake facility	
					Eliminate permitting issues associated with Alternative D	

Scenario 1: Transmission to Bachman WTP
Alternative Route A

Bachman Lake

Bachman WTP

Estelle Creek

Bear Creek

Delaware Creek

Elm Fork Trinity River

Trinity River

Vilbig Lakes

West Fork Trinity River

West Dallas Housing Project Lake

Bluebonnet Lakes

Texaco Lake

Coombs Creek

Cottonwood Creek

Mountain Creek Lake

Crow Creek

Kirby Creek

Artesian Creek

Mountain Creek

O'Guinn Creek

Fivemile Creek

Fish Creek

JOE POOL LAKE

Tenmile Creek

Mauk Branch

Legend

- Streets
- Rivers and Streams
- Alternative Route A

N W E S

TARRANT REGIONAL WATER DISTRICT

dallas water utilities
city of dallas

CDM/KBR

0 2,500 5,000 Feet

Figure 8-2

Scenario 1: Transmission to Bachman WTP
Alternative Route B

Bachman Lake
Bachman WTP
Estelle Creek
Elm Fork Trinity River
Delaware Creek
Trinity River
Vilbig Lakes
West Fork Trinity River
Bear Creek
Johnson Creek
Bluebonnet Lakes
Texaco Lake
Coombs Creek
Cottonwood Creek
Mountain Creek Lake
Kirby Creek
Artesian Creek
O'Guinn Creek
Fivemile Creek
Crow Creek
Mountain Creek
Fish Creek
JOE POOL LAKE

Legend

- Streets
- Rivers and Streams

Alternative Route B

- Open Channel Flow
- Pumped Flow

N
W
E
S

Tarrant Regional Water District
dallas water utilities
city of dallas

Figure 8-3

CDM/KBR

0 2,500 5,000 Feet

Scenario 1: Transmission to Bachman WTP
Alternative Route C

Las Colinas Reservoir Number 7
Estelle Creek
Joes Creek
Bachman Lake
Bachman WTP
Elm Fork Trinity River
Delaware Creek
Trinity River
Vilbig Lakes
West Fork Trinity River
Bear Creek
West Dallas Housing Project Lake
Bluebonnet Lakes
Texaco Lake
Coombs Creek
Cottonwood Creek
Mountain Creek Lake
Kirby Creek
Artesian Creek
Mountain Creek
O'Guinn Creek
Fivemile Creek
Crow Creek
Fish Creek
Mauk Branch
JOE POOL LAKE
Tenmile Creek

Legend

- Streets
- Rivers and Streams

Alternative Route C

- Open Channel Flow
- Pumped Flow

N
W
E
S

Tarrant Regional Water District
dallas water utilities
city of dallas
CDM/KBR

0 2,500 5,000 Feet

Figure 8-4

Scenario 1: Transmission to Bachman WTP
Alternative Route D

Lake Carolyn
Las Colinas Reservoir Number 7
Joes Creek
Bachman Lake
Bachman WTP
Elm Fork Trinity River
Delaware Creek
Trinity River
Vilbig Lakes
West Dallas Housing Project Lake
West Fork Trinity River
Bluebonnet Lakes
Texaco Lake
Coombs Creek
Cottonwood Creek
Mountain Creek Lake
Johnson Creek
Kirby Creek
O'Guinn Creek
Crow Creek
Artesian Creek
Fivemile Creek
Fish Creek
Mountain Creek
Mauk Branch
Woody Branch
Lynn Creek
JOE POOL LAKE
John Penn Branch
Bowman Branch
Stewart Branch
Tenmile Creek
Baggett Branch
Bentle Branch
Bee Branch
Heath Creek
Walnut Creek
Magic Valley Ranch Lake
Little Creek
Bear Creek
Low Branch
Red Oak Creek
Hollings Branch
Bedford Branch
Gifford-Hill Lake
North Prong Creek
Soil Conservation Service Site 11 Reservoir
Reece Branch
Soap Creek
Soil Conservation Service Site 1 Reservoir
Soil Conservation Service Site 10 Reservoir

0 4,000 8,000 Feet

Legend

- Streets
- Rivers and Streams
- Alternative Route D
- TRWD RC/CC Pipelines

Figure 8-5

CDM/KBR

Scenario 1: Transmission to Bachman WTP
Alternative Route E

Lake Carolyn
Lake Carolyn
Joes Creek
Bachman Lake
Bachman WTP
Elm Fork Trinity River
Delaware Creek
Trinity River
Vilbig Lakes
West Dallas Housing Project Lake
Bluebonnet Lakes
West Fork Trinity River
Texaco Lake
Johnson Creek
Coombs Creek
Cottonwood Creek
Mountain Creek Lake
O'Gunn Creek
Fivemile Creek
Kirby Creek
Crow Creek
Artesian Creek
Fish Creek
Mountain Creek
Mauk Branch
Woody Branch
Lynn Creek
JOE POOL LAKE
Bowman Branch
John Penn Branch
Stewart Branch
Tenmile Creek
Baggett Branch
Bentle Branch
Bee Branch
Heath Creek
Walnut Creek
Magic Valley Ranch Lake
Little Creek
Low Branch
Bedford Branch
Hollings Branch
North Prong Creek
Soap Creek
Gifford-Hill Lake
Soil Conservation Service Site 11 Reservoir
Soil Conservation Service Site 1 Reservoir

0 4,000 8,000 Feet

Legend

- Streets
- Rivers and Streams
- Alternative Route E
- TRWD RC/CC Pipelines

Figure 8-6

CDM/KBR

8.3.2 Conveyance Cost Analysis

The alternative route in Scenario 1 with the combination of highest probable cost and lowest probably disadvantage was selected for the conveyance cost analysis. This selection does not indicate a preference for this route but does provide the decision-maker with a result that bounds the possible cost implications. Alternative route E was selected over the other highest probable cost alternative (route D) because it does not pass through federal and protected park lands on the east of Joe Pool Lake and because it enables gravity transmission to Bachman WTP, as opposed to the higher ground elevations of Alternative D that would lead to more complicated transmission hydraulics.

Alternative route E begins at the southwest corner of Joe Pool Lake at an approximate ground elevation of 600 feet. Using a ground storage tank (GST) to serve as a balancing reservoir for the pipeline, which drops approximately 190-feet from the location of the GST to the headworks of Bachman WTP, a 78-inch pipeline enables gravity flow for the entire length of the route at a design flow of 128 MGD without the need of a booster pump station. Because alternative route E does not utilize a pump station, energy costs do not factor into the life-cycle cost analysis.

Based on the capital and life-cycle cost assumptions described in Sections 1 and 3, the opinion of capital cost for alternative route E in Scenario 1 is $171,132,000 and the Present Value of the 50-year life-cycle cost is $258,729,000.

8.3.3 Bachman WTP

In addition to the conveyance system to Bachman WTP, Scenario 1 includes treatment of raw water from Lake Palestine that has blended with Cedar Creek Reservoir water. The raw water quality for this scenario is as follows:

- Alkalinity 60 mg/L
- Hardness 5 0 mg/L
- TOC 7.0 mg/L
- TDS 132 mg/L
- Bromide 0.09 – 0.12 mg/L
- Iron 81 ug/L
- Manganese 97 ug/L

The treatment process at Bachman WTP, with projected modifications to include biological filtration, would sufficiently treat this raw water supply to meet desired water quality goals. However, due to elevated levels of TOC and manganese, additional ferric sulfate would be required to meet TOC reduction targets and

additional ozone would be required for manganese oxidation and potentially increased demand from higher organic content in the water.

Currently planned improvements to the Bachman WTP include modifications for enhanced coagulation. These improvements include additional chemical storage and feed facilities that would be sufficient for treating the higher levels of TOC associated with Scenario 1.

To facilitate oxidation of the increased levels of manganese in the Lake Palestine/Cedar Creek Reservoir blend, approximately 200 lb/day of ozone would be required. This is a small percentage of the current overall ozone capacity at the plant and existing ozone generators would likely have sufficient capacity to meet this additional requirement. Ozone generation capacity could also be increased by decreasing the ozone in oxygen concentration during periods of high flow and high ozone demand.

Because no additional facilities would be required at the Bachman WTP, the estimated capital cost is zero. The probable operating cost for Scenario 1 (chemicals and power for ozone production) is $60 per MGal treated. This evaluation assumes that the existing Bachman WTP can meet the 102 mgd capacity requirement for Lake Palestine water. However, it does not include the costs for expanding the City's overall treatment plant capacity by 102 mgd. This would likely be done by expanding the Elm Fork WTP by 102 mgd. The cost for expanding such an existing facility, if room for expansion is available, would be comparable to a new plant of the same size, approximately $200,000,000.

8.4 Scenario 2 – Southeast WTP

In this analysis, Scenario 2 correlates to the cost and water quality analysis found in Project Conveyance Alternative 1 (independent system with DWU connection to the SEWTP). Costs from this scenario are additive to Alternative 1 costs and the raw water used in this scenario (Lake Palestine only) is the same as that in Alternative 1. Scenario 2 includes treatment of raw water from Lake Palestine at the new Southeast WTP. The raw water quality for this scenario is as follows:

- Alkalinity 38 mg/L
- Hardness 48 mg/L
- TOC 8.5 mg/L
- TDS 138 mg/L
- Bromide 0.12 mg/L
- Iron 110 ug/L
- Manganese 250 ug/L

The selected treatment process (see Section 8.2.2) would sufficiently treat this raw water supply to meet target water quality goals. However, due to low alkalinity and elevated levels of TOC and manganese, the water will be more difficult to treat than the raw water from Scenario 1, and will require greater quantities of treatment chemicals. Additional ferric sulfate would be required to meet TOC reduction targets and additional ozone would be required for manganese oxidation and potentially increased demand from higher organic content in the water.

The probable construction cost for a conventional water treatment plant with ozonation facilities and onsite sludge lagoons is approximately $2.00 per gallon. This cost is based on recent (2008) construction cost bids for similar facilities. The construction cost of a new 102 mgd water treatment plant would be approximately $204 million. To account for additional ozonation facilities and chemical storage and feed facilities, this cost was increased by 5%. Therefore, the probable capital cost for the new 102 mgd Southeast WTP would be approximately $215,000,000. The probable operating cost (chemicals and power for ozone production) is $66 per MGal treated.

8.5 Scenario 3 – WTP at Joe Pool Lake

In this analysis, Scenario 3 correlates to the cost and water quality analysis found in Project Conveyance Alternative 3 (Interconnected Third Pipeline). Costs from this scenario are additive to Alternative 3 costs and the raw water used in this scenario is the same as that in Alternative 3, a blend of Lake Palestine and Cedar Creek Reservoir water. Scenario 3 includes treatment of raw water from Lake Palestine that has blended with Cedar Creek Reservoir water. It was assumed that raw water would be pulled off prior to discharge into Joe Pool Lake and treated at a new water treatment plant near Joe Pool Lake. The raw water quality for this scenario is as follows:

- Alkalinity 60 mg/L
- Hardness 50 mg/L
- TOC 7.0 mg/L
- TDS 132 mg/L
- Bromide 0.09 – 0.12 mg/L
- Iron 81 ug/L
- Manganese 97 ug/L

The selected treatment process (see Section 8.2.2) would sufficiently treat this raw water supply to meet target water quality goals. The raw water quality is the same as Scenario 1 and would require the same treatment process and treatment requirements. Therefore, the probable construction cost of a new 102 mgd water treatment plant near Joe Pool Lake would be approximately $204 million, not

including the potential cost of purchasing a treatment plant site. The probable operating costs (chemicals and power for ozone production) are $60 per MGal treated.

8.6 Mountain Creek Lake Considerations

8.6.1 Mountain Creek Lake Overview

Mountain Creek Lake was built as a cooling reservoir for a power plant originally constructed in 1938. The reservoir is still used for cooling purposes at the Mountain Creek Generating Station. This power plant is operated by Exelon Corporation according to the Exelon web site[2]. The annual use reports reviewed indicate that this plant may divert between about 120 cfs and in excess of 900 cfs for cooling and other industrial purposes. The TCEQ tabulation of water rights and documents available of record from the TCEQ do not indicate any other CA or permit holder for water from Mountain Lake. TCEQ staff confirmed that it is unlikely another CA or permit holder exists, but that there can be infrequent omissions in the TCEQ database.

Technical Data on Mountain Creek Lake

Water Right – Certificate of Adjudication 08-3408

Water Right Owner – ExTex LaPorte

Reservoir Owner – ExTex LaPorte

Stream – Mountain Creek, tributary of the Trinity River

County – Dallas County

Conservation Storage Capacity – 22,840 acre-feet

Maximum Diversion – "Owner is authorized to divert and consumptively use not to exceed 6400 acre-feet of water per annum from the aforesaid reservoir for industrial purposes."

Maximum Diversion Rate – The maximum combined rate of diversion specified in Certificate of Adjudication 08-3408, Paragraph 3.B. has been marked out in the copy received from TCEQ. No maximum diversion rate is specified in the tabulation of water rights maintained by TCEQ.

Priority Date: March 12, 1929

Environmental Flow Requirements – none indicated in materials reviewed

As with the other reservoirs we have studied on the Trinity River, the water right for Mountain Creek Reservoir does not expressly authorize surface water to be stored in the reservoir from sources outside the Trinity River basin, nor does the water right preclude such storage. The CA also did not include special provisions,

[2] ExTex LaPorte and Exelon appear to be related entities.

such as environmental flow requirements or conservation requirements for wholesale water users that would otherwise affect storage or transmission of water from outside the Trinity River basin in or through Mountain Creek Reservoir.

We note that the Mountain Creek Generating Station pumps a large amount of water from Mountain Creek Reservoir for cooling and other industrial purposes. This may cause the reservoir level to fluctuate, affect the temperature of the water in the reservoir, and otherwise affect water passing through the reservoir. The CA for the reservoir is senior to that of the Lake Palestine transfer (and most other water rights in the area), and so the transfer must be implemented so as to not affect these senior rights. The CA allows the holder to divert and consumptively use only 6,400 acre-feet of water annually. According to the annual use reports, the generating station diverted 491,230.81 acre-feet from Mountain Creek Lake in 2004, and consumed 1084.456 acre-feet. These figures are consistent with or lower than past years. Our interpretation of the diversion restriction imposed by the CA is that the power plant is currently exceeding its allowable diversions, but that these large diversions may not detrimentally affect the amount of water available to other water right holders. Any subsequent use of the reservoir by Dallas Water Utilities would need to take into account the generating station's permitted diversions rather than its current actual diversions.

See **Figure 8-7**, prepared by the City of Dallas, depicting the general location of Mountain Creek Lake and its watershed.

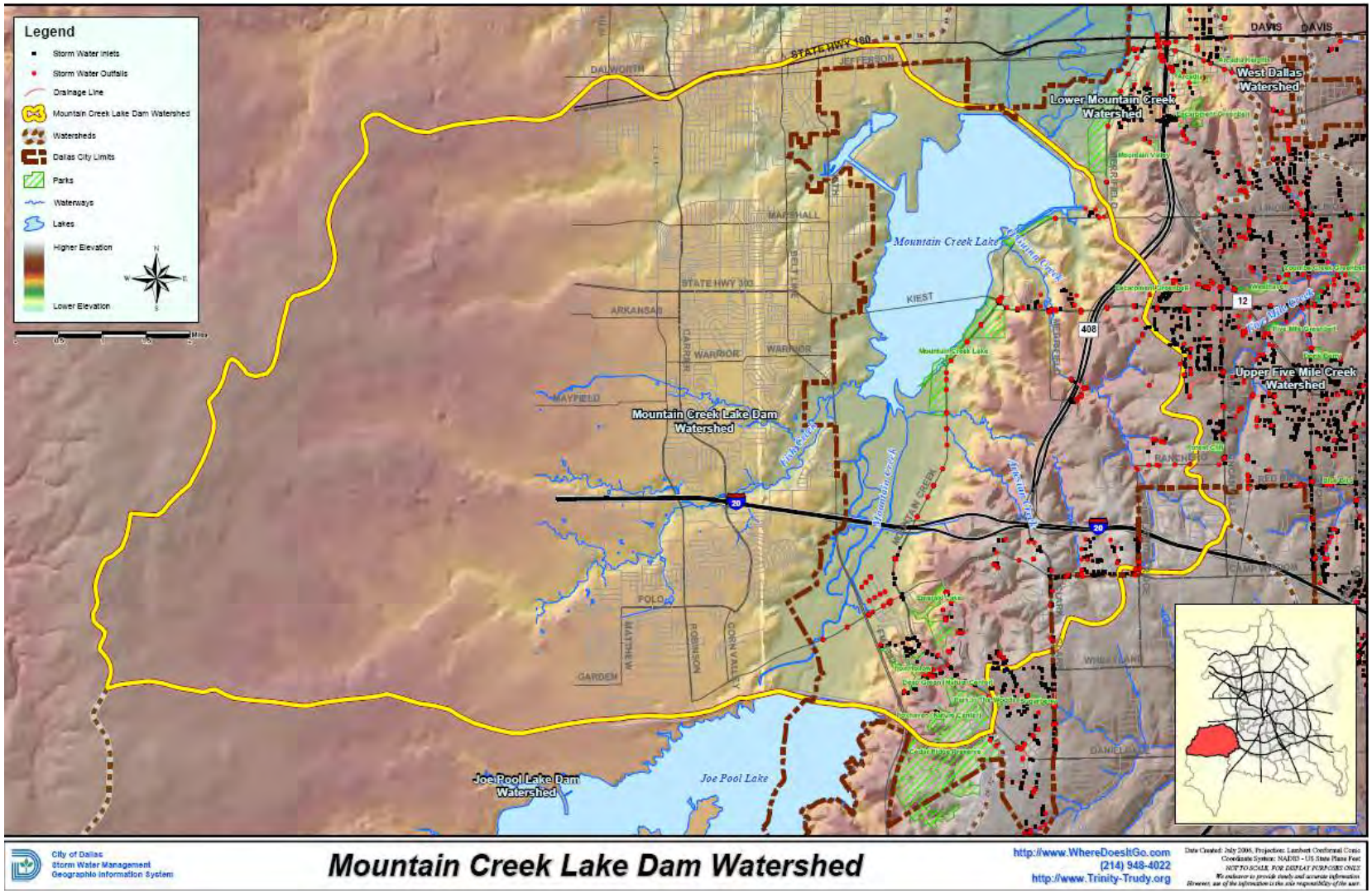


Figure 8-7
Mountain Creek Lake Dam Watershed

8.6.2 Mountain Creek Water Quality

Under one of the alternative routes in Scenario 1 discussed above, 102 mgd of the interconnected TRWD/DWU water would be routed from Joe Pool Lake through Mountain Creek Lake to the Bachman WTP. The Texas Commission on Environmental Quality (TCEQ) has identified water quality concerns in Mountain Creek Lake. The following provides a summary of the water quality concerns associated with this water body and evaluates their importance with regards to the water routing proposal.

Existing Water Quality

The following sections summarize what is known regarding existing water quality in Joe Pool and Mountain Creek Lakes.

Joe Pool Lake – Joe Pool Lake is a 7,470 acre reservoir that is protected for the following beneficial uses: Aquatic life, contact recreation, general, fish consumption and public water supply. Reservoir water quality is regularly assessed by TCEQ every two years; the latest draft assessment was completed in March 2008 (TCEQ 2008). This assessment reported that water quality in the reservoir is good with all assessed beneficial uses fully supported – including the public water supply use. The 2008 findings are consistent with assessments completed in previous years.

Mountain Creek Lake – This lake is a 2,710 acre reservoir that is protected for the following beneficial uses: Aquatic life, contact recreation, general, fish consumption and public water supply. In contrast to Joe Pool Lake, this reservoir has water quality concerns – but only as applicable to the protection of the fish consumption use (TCEQ 2008). No concerns have been identified for other beneficial uses, e.g., public water supply (TCEQ 2008).

The fish consumption advisory was issued on April 25, 1996 as result of lake studies conducted in 1994-1995 by the U.S. Geological Survey (see Van Metre et al. 2003). These studies showed elevated concentrations of PCBs, chlordane, heptachlor epoxide, and DDT (and its byproducts DDD and DDE), in sediments and fish tissue that exceeded Texas Department of Health (TDH) guidelines for the consumption of fish. Sources of these contaminants date back to activities occurring along and near the lake at the Naval Air Station Dallas and the Naval Weapons Industrial Reserve Plant, primarily from 1941 to 1974.

Changes in discharge practices and implementation of state and federal environmental laws and regulations since the 1970s have resulted in a gradual improvement in sediment quality. For example, Van Metre et al. (2003) showed substantial differences in sediment quality with sediment depth in the lake bottom. Older, deeper sediments had substantially higher levels of contaminants than newer, surficial sediments. This change demonstrates that contaminant control and

remediation activities are resulting in a greatly reduced load of contaminants to the reservoir.

Van Metre et al. (2003) identified a number of concerns regarding contaminants in fish tissue including PCBs and various organochlorine pesticides. For metals, only selenium was identified as a concern, but no concerns were identified for other organic chemicals such as polycyclic aromatic hydrocarbons (PAHs) and volatile organic compounds (VOCs).

Ultimately, the outcome from the findings of this study was the listing of Mountain Creek Lake as an impaired waterbody requiring a Total Maximum Daily Load (TMDL) to address impairment of the fish consumption use. This listing was based solely on the fish tissue data and resulting fish consumption advisory for the following contaminants: DDT, DDD, DDE, chlordane, dieldrin, PCBs and heptachlor epoxide. The listing was not based on the finding of any contaminants at levels of concern in the water column.

In June 2001, the Environmental Protection Agency approved a TCEQ adopted TMDL established, in part, to address the fish consumption impairment in Mountain Creek Lake (TCEQ, 2000). Subsequently, the TCEQ adopted a plan to implement the EPA-approved TMDL (TCEQ, 2001). This plan relies on the continued remediation of contaminant sources at source sites (e.g., Naval Air Station) to prevent any additional loadings to the lake, e.g., through the runoff of stormwater, and the passage of time to achieve compliance. As correctly noted in the TMDL, source control is critical so that no new loadings to the waterbody occur, but a key means for achieving success is to allow time for natural attenuation processes to occur.

Natural attenuation relies on the natural process of sedimentation to the lake to deposit clean sediment over contaminated sediment. Clean bottom sediments prevent contaminants from being consumed by invertebrates which are in turn consumed by fish resulting in bioaccumulation in fish tissue. Over time (many years) the result of natural attenuation will be a gradual reduction in fish tissue concentrations. The time to success will be improved the more quickly the sources of contaminants in the watershed are eliminated.

Efforts to reduce contaminant loadings have been ongoing for some time. TDH (2002) provides evidence that this process is gradually improving water quality. They note that in 1995 67 of 68 fish tissues samples contained the PCB congener Aroclor 1260. Of 10 samples collected in 2000 and 2001 Aroclor 1260 was detected in only one fish sample. Although this result suggests that water quality management efforts are resulting in water quality improvements, TDH wanted to collect more data before determining whether PCB levels were low enough to support removal of the fish consumption advisory (at least for PCBs). As of this date, the fish consumption advisory remains in place.

Water Quality Discussion and Recommendations

Based on the review of Joe Pool Lake and Mountain Creek Lake water quality data, it is unlikely that routing water through Mountain Creek Lake to Bachman WTP will result in any drinking water quality concerns. This finding is based on the following:

- Water quality in the source water (Joe Pool Lake plus Lake Palestine, or Lake Palestine/Cedar Creek Reservoir blends) is good and the blended interconnected supplies would be acceptable for drinking water uses as previously discussed in Section 5;

- TCEQ has repeatedly made a regulatory finding that water quality in Mountain Creek Lake fully supports the Public Water Supply beneficial use.

- Water quality concerns in Mountain Creek Lake are limited to sediment and fish tissue – not the water itself. These concerns are also primarily associated with the Cottonwood Bay portion of the reservoir and not the main lake.

- A TMDL has been established which is aggressively addressing contaminant loadings to the reservoir.

- Evidence exists (TDH 2002) that contamination mitigation efforts are resulting in less contamination in fish tissue.

While these findings suggest that routing water through the reservoir is a viable option with regards to water quality, the following recommendations should be considered if that option is pursued:

- Because a TMDL exists on the reservoir, this option should be discussed with TCEQ to identify any concerns that they may have. Discharging water from Joe Pool Lake to Mountain Creek Reservoir changes the dynamics of the reservoir and may need to be factored into TCEQ's TMDL implementation program.

- The TCEQ periodically assesses water quality in Mountain Creek Lake as part of the state biannual waterbody assessment process. If this reservoir becomes a source location for the Bachman WTP, the treatment facility may want to conduct additional source water sampling to supplement TCEQ's monitoring program.

8.7 Summary and Conclusions

Table 8-3
DWU Additional Treatment and Water Transmission Facilities
Summary Conclusions

Results	DWU Scenario		
	1 Bachman WTP	**2 Southeast WTP**	**3 WTP at Joe Pool**
Conveyance Capital Cost[(1)]	$171,132,000	n/a	n/a
Treatment Infrastructure Capital Cost	No Cost at Bachman WTP + Elm Fork Expansion (~$200,000,000)	$215,000,000	$204,000,000
Treatment Op. Cost (per MGal Treated)	$60	$66	$60
Present Value of 50-year Life-Cycle Cost	$782,604,000[(2)]	$572,321,000	$554,872,000
Notes	Costs for expanding DWU's overall treatment plant capacity by 102 mgd (by expanding the Elm Fork WTP if room for expansion is available) would be comparable to a new plant of the same size	Cost for conveyance is included in Project Conveyance Alternative costs	Cost for conveyance is included in Project Conveyance Alternative costs

Note (1): Distribution system costs (downstream of the WTP) are not included.

Note (2): The replacement of 102 mgd capacity at Elm Fork WTP is included in this figure. If this cost is excluded, the Present Value of the 50-year life-cycle cost is $335,572,000.

Modifications to Bachman WTP treatment process:

- Biological filtration (currently being implemented);
- Additional ferric sulfate storage and feed facilities to meet desired TOC reduction (current enhanced coagulation improvements should meet these requirements); and
- Additional ozone generation capacity (approximately 200 lb/day) for manganese oxidation (existing plant ozonation facilities should be capable of providing this increased ozone requirement)

Proposed Southeast WTP

- Due to low alkalinity and elevated levels of TOC and manganese, the water would be more difficult to treat than the raw water from Scenario 1 (at Bachman WTP);
- Additional ferric sulfate addition would be required to meet desired TOC reduction; and

- Additional ozone would be required for manganese oxidation and due to increased demand from higher organic content in the water.

Proposed Joe Pool Lake WTP: raw water quality would be the same as that for Scenario 1 (at Bachman WTP) and would require the same treatment process and treatment requirements.

Mountain Creek Lake

The Mountain Creek Lake water right does not expressly authorize surface water to be stored in the reservoir from sources outside the Trinity River basin, nor does the water right preclude such storage. The Certificate of Adjudication also does not include special provisions, such as environmental flow requirements or conservation requirements for wholesale water users that would otherwise affect storage or transmission of water from outside the Trinity River basin in or through Mountain Creek Lake.

Based on the review of Joe Pool Lake, Lake Palestine, Cedar Creek Reservoir and Mountain Creek Lake water quality data, it is unlikely that routing water through Mountain Creek Lake to Bachman WTP will result in any significant drinking water quality concerns. These findings suggest that the option to route water through Mountain Creek Lake is a viable option with regards to drinking water quality.

Section 9
Preliminary Findings and Recommendations

9.1 Preliminary Findings

The purpose of this initial Project Viability Assessment and Business Case Evaluation was to 1) identify any "fatal flaws" to developing an integrated raw water transmission system; and 2) compare the separate, independently adopted water strategies of both TRWD and DWU with integrated raw water delivery system alternatives in terms of their life-cycle cost implications, water quality and treatment implications, and permitting and environmental issues. Six tasks were completed as part of this initial Project Viability Assessment and Business Case Evaluation.

1. Integrated system operations analysis;
2. Capital and life-cycle cost analysis;
3. Facility siting constraints assessment;
4. Environmental water quality review;
5. Consideration of water treatment impacts; and
6. Permitting and regulatory review.

At the outset of this initial Project Viability Assessment and Business Case Evaluation, the project team recognized that separate, sound water management strategies are already in place for both DWU and TRWD and that any integrated, joint-agency approach would need to meet several key objectives to complement or replace existing plans:

- An integrated raw water transmission system alternative must enhance the redundancy, flexibility, and demand risk management of the existing water supply systems;
- An interconnected plan must make sufficient water supply available to meet demands where and when needed, under a full range of historical hydrological conditions;
- An integrated raw water transmission system alternative must reduce capital and life-cycle costs, while not contributing to unmitigated treatment or distribution costs for DWU or TRWD customers; and

- All scenarios must fully consider societal, environmental, and regulatory complexities

With these key objectives guiding the way, four project conveyance alternatives were developed through a progressive screening approach to evaluate combinations of conveyance infrastructure and interconnections. Two Baseline Alternatives (independent water strategies) and the two most promising Interconnection Alternatives (integrated delivery systems) were then selected (as described in **Table 1-1** and repeated below for the reader's convenience). Key findings from the six tasks as they relate to the objectives listed above are here presented based on the analysis of these four project conveyance alternatives.

Alternative	Description
1 (Baseline)	Independent Systems: TRWD's East Texas Third Pipeline and DWU's connection of Lake Palestine to the proposed Southeast Water Treatment Plant
2 (Baseline)	Independent Systems: TRWD's East Texas Third Pipeline and DWU's connection of Lake Palestine to Joe Pool Lake
3 (Interconnection)	Integrated System: Interconnected Third Pipeline (upsized as compared to the baseline condition) with connection of Lake Palestine to Cedar Creek Reservoir and delivery to DWU at Joe Pool Lake and TRWD's customers through the Third Pipeline
4 (Interconnection)	Integrated System: Interconnected "Southern Pipeline" - Lake Palestine delivered to the Lake Benbrook pipeline via a pipeline route to the south of the TRWD Third Pipeline route. Delivery to DWU at Joe Pool Lake and TRWD's customers through connections to the existing system and the Lake Benbrook pipeline.

9.1.1 Conclusions from Integrated Operations Analysis

The purpose of this analysis was to identify opportunities for benefits, or potential disadvantages, to both TRWD and DWU through integrated operations of the raw water transmission systems from Lake Palestine, Richland-Chambers Reservoir, and Cedar Creek Reservoir. This comparison of Baseline Alternatives 1 and 2 with Interconnection Alternatives 3 and 4 (see Table 1-1) was driven by a system operations model and the team's water resource planning experience. This model was formulated as a decision-support system that permitted the user to create an array of scenarios that help answer a series of primary and secondary questions, formulated jointly by the project participants during workshops:

In this context, we can conclude the following regarding operating costs, water sharing and timing, redundancy, flexibility, and regional cooperation:

9.1.2 Operating Costs

The integrated operations modeling shows that operating costs within the bounded system are lower in interconnected alternatives as compared to baseline alternatives. This opportunity for operational cost savings is more pronounced in the near term and decreases over time as the difference between interconnected and independent

operations is minimized. This near-term savings is attributed to the fact that the full amount of DWU water supply from Lake Palestine is not required immediately. (DWU access to the TRWD supply system could extend the need to connect the Lake Palestine supply to each system.)

9.1.3 Water Sharing and Timing

The integrated operations modeling found that there is opportunity to make extra water available to water user groups via an interconnected system. The analysis suggests that even under drought conditions in 2020, approximately 80 additional mgd could be available. This result is based on three modeling protocols: 1) water availability is limited by existing TRWD permits (for Richland-Chambers, Cedar Creek, and the planned wetlands); 2) DWU demand is equal to the contracted amount in Lake Palestine (102 mgd); and 3) conveyance is limited by the capacity of existing and planned TRWD conveyance facilities.

This result also confirms that Lake Palestine supply will be required prior to 2020 if the DWU demand reaches 102 mgd (though not all of it will be required immediately and dependence upon it as a source could conceivably be phased). Additions to conveyance capacity could be phased through 2030. TRWD requires water supply in addition to sources already included in the model, such as the constructed wetlands, between 2030 and 2040 (based on existing permit constraints and projected demands).

Interconnection also provides the opportunity for TRWD to use the 102 mgd from Lake Palestine. This water sharing may be useful in an emergency situation or in a localized drought condition that causes deficit in the TRWD system while excess is available to DWU. This opportunity to share water between the two water providers is also a method of demand risk management to mitigate the effects of unforeseen demand growth patterns in the TRWD or DWU systems.

By the year 2030, any configuration of the system becomes supply limited, and reliability predictions during severe droughts would be roughly equivalent among configurations. However, during normal hydrologic periods, extra supply is available through 2060 in an interconnected system, though TRWD may have conveyance limitations to accessing the water. The analysis also indicates that the TRWD system can support sustained withdrawals above the current permitted levels. In other words, supply is limited by the permitted amounts, not water availability.

With an interconnected system, any additional water above projected demands would conceivably be available to any water user group, provided that conveyance capacity would be adequate. With separate systems, this water would not be available to DWU and TRWD and its customers would not benefit from potential sales or trades of water above projected TRWD customer demands. With an interconnected system, there is also the possibility of bringing other, currently independent sources (such as DWU reuse water) and new water supply sources (Toledo Bend, Oklahoma, etc.) into the interconnected system to enhance the potential for water sharing.

To satisfy the DWU demands as they are represented in the model, the full yield of Lake Palestine (102 mgd) is needed immediately if the two systems remain separate. If conveyance systems are interconnected, use of Lake Palestine could ramp up gradually (assuming TRWD water supply in excess of projected demands could help satisfy DWU demand). This offers significant benefits with respect to phased infrastructure that are not available with separate systems.

9.1.4 Redundancy

Operational redundancy is a "belt and suspenders" approach to risk management that enables the water supplier to select from multiple supply sources in times of emergency, drought, failure, etc. An interconnected supply system therefore provides more opportunity for supply and failure risk management.

In the event of a pipe failure or power outage, an integrated transmission system has more alternative flow pathways and connections to multiple water and power sources. These additional connections lower risk to the water provider. The impacts of climatic variations are also lessened because of the diversification of reservoir locations. An interconnected system "casts a wider net" to reservoirs in different watersheds that will potentially experience drought in different times or levels of severity. Also, access to additional sources that may not be fully utilized adds supply redundancy to the system.

9.1.5 Operational Flexibility

Under prevailing ("normal") hydrologic conditions when the modeled system is not supply-limited, an interconnected system offers more operational flexibility than separate sources, since multiple flow pathways could be used to transport water. Such flexibility could be used to capitalize on advantageous opportunities for blending of sources, pump cycling schedules, system maintenance and energy management. One potential disadvantage of operations in an integrated system is the potential for increased operational complexity and the attendant new systems and protocols that must be developed to manage such a system.

The interconnected system also provides flexibility in terms of water availability. Extra supply is available through 2060 in an interconnected system and the analysis indicates that the TRWD system can support sustained withdrawals above the current permitted levels. This ability to overdraft supply sources provides flexibility to system operations, the potential for lower operating costs, and risk mitigation.

The National Water Research Institute in its November 2007 white paper entitled "Water 2010: A 'Near Sighted' Program of Water Resource Management Improvements for the Western United States" recommended system interties as its number one action item for state and local policymakers. NWRI concluded that "System interties increase the flexibility of system operators to respond to weather events, natural disasters, contaminations incidents, or the need to take water treatment or conveyance facilities temporarily off-line for repair or

refurbishment……many interconnections can be planned and constructed within just a few years and at a relatively low cost."

9.1.6 Regional Cooperation

TRWD and DWU have a long history of cooperation in water supply planning, including the Texas Water Development Board regional water planning efforts initiated by the 1997 passage of Senate Bill 1 in the 75th session of the Texas Legislature. This on-going cooperation has led to this study and the potential for raw water transmission system interconnection. The interconnection of the two systems provides opportunities for benefit to both agencies by laying the groundwork for interconnecting future water supply sources (Toledo Bend, Oklahoma, etc.), increasing the portfolio of water supply options, reducing the costs of right-of-way through earlier acquisition, providing financing risk management, and compliance with TWDB planning guidelines.

The groundwork for regional cooperation in accessing future water supply options has already been laid; integrated water supply infrastructure provides additional opportunity for cost savings and will facilitate future inter-local agreements. By interconnecting the transmission system, each agency also effectively increases its portfolio of water supply options through the potential to share water and infrastructure.

Escalating costs for right-of-way acquisition (and urbanization) also point to the benefits of securing transmission routes early. This early acquisition presents an opportunity to acquire sufficient right-of-way for future joint water supplies. TRWD has recently experienced the following average costs for securing easements for several large diameter transmission system projects, costs which raise the issue of expedited acquisition of right-of-way for this and other future joint projects:

- Real estate classified as rural - $15,415 per acre.
- Real estate classified as undeveloped, planned - $33,792 per acre.
- Real estate classified as developed - $71,247 per acre.

Escalation in the cost of materials and ever increasing pressure on the financing market also point to the benefits of interconnection. Economies of scale and the ability to leverage the joint financing capacity of both agencies are benefits in integration.

Along with the other opportunities for benefits through integration, this regional cooperation is in compliance with TWDB guidelines for water supply planning. These guidelines and the TWDB planning process require this cooperation.

9.1.7 Summary of Integrated Operations Conclusions

From an operational perspective, the analysis supports further investigation of interconnected conveyance alternatives. Unlike separate systems, an interconnected system that routes Lake Palestine through the planned TRWD system offers reduced operating costs, cost sharing, savings due to infrastructure phasing, opportunities for water sharing, the potential for increased overall system yield and supply reliability, redundancy, and operational flexibility with respect to infrastructure scheduling and daily operations.

These results indicate a broad range of potential benefits that could be realized with an interconnected system as opposed to separate systems. Subsequent sections of this report address other factors relevant to interconnections, such as water quality, treatment requirements, environmental impacts, etc. Subsequent phases of work will establish operating protocols and cost agreements for shared conveyance and shared supply, and will address permitting needs.

9.1.8 Lifecycle Cost Analysis

Results from this screening level cost analysis show that there are opportunities for significant cost savings through integrated conveyance system alternatives to deliver DWU and TRWD supplies. Delivering water through an Interconnected Third Pipeline has potential Present Value, 50-year lifecycle cost savings between approximately $220,000,000 and $540,000,000.

The Interconnected Southern Pipeline alternative has potential Present Value, 50-year life-cycle cost savings when compared to Alternative 2 (baseline with delivery to Joe Pool) but increased cost when compared to Alternative 1 (baseline with delivery to SE WTP). However, because the Interconnected Southern Pipeline delivers water to Joe Pool Lake and not the SE WTP, the most direct comparison is between the Interconnected Southern Pipeline and Alternative 2, which results in an approximate $36,600,000 savings. Subsequent phases of this feasibility assessment will consider other potential benefits from the Southern Pipeline, such as supply risk reduction and right-of-way acquisition for future supplies. Escalating costs raise the issue of expedited acquisition of right-of-way (e.g. in the Southern Pipeline route) to manage the availability and cost of acquisition for this and future water supplies from East Texas. Also, phasing could also result in significant reduction of costs associated with the Interconnected Southern Pipeline due to the potential to defer development of transmission facilities required to deliver water to Lake Benbrook.

9.1.9 Environmental Water Quality and Water Treatment

Integrating Lake Palestine water into the DWU and TRWD raw water supply systems will have a low to moderate impact on environmental water quality and treatment at the receiving reservoirs and at the water treatment plants. The major impacts of the Lake Palestine water on water treatment relate to its low alkalinity, high TOC, and high manganese concentrations. The importation of Lake Palestine water will result in higher nutrient levels at the studied receiving reservoirs but will not likely to lead

to impacts that impair the designated uses of the water bodies. Additional studies will help predict the complex kinetic relationships between nutrients and chlorophyll-a, particularly for those reservoirs where additional water management strategies include supply augmentation with reuse water.

9.1.10 Ellis and Johnson Counties

The Region C Four County Study (by Freese & Nichols, Inc.) concluded that population and demand projections are exceeding those included in the 2006 Region C water plan. Both TRWD and DWU have existing and projected wholesale customers in Ellis and Johnson Counties to be served by the integrated conveyance systems analyzed in this study. Further development of the raw water transmission integration alternatives will allow TRWD and DWU to consider how these demands can be jointly met in terms of supply, infrastructure and contractual agreements, including advancement of the Trinity River Authority Ellis County Water Supply Project recommended in the Region C Water Plan.

9.1.11 DWU Additional Treatment and Transmission Facilities

This task considered additional cost and treatment implications for transmission of raw water to DWU treatment and distribution system facilities from project conveyance Alternatives 1 and 3, which respectively represent the independent and interconnected raw water transmission system. These additional treatment and water transmission facilities that may be required for a fully functional integrated strategy for DWU were beyond the initial study boundary; therefore, costs implications in this section are additive to the project conveyance alternative costs. These costs do not include distribution system improvements needed downstream of the water treatment plants.

Table 9-1
DWU Additional Treatment and Transmission Facilities

Results	DWU Scenario		
	1 Bachman WTP	**2 Southeast WTP**	**3 WTP at Joe Pool**
Conveyance Capital Cost(1)	$171,132,000	n/a	n/a
Treatment Infrastructure Capital Cost	No Cost at Bachman WTP + Elm Fork Expansion (~$200,000,000)	$215,000,000	$204,000,000
Treatment Op. Cost (per MGal Treated)	$60	$66	$60
Present Value of 50-year Life-Cycle Cost	$782,604,000(2)	$572,321,000	$554,872,000
Notes	Costs for expanding DWU's overall treatment plant capacity by 102 mgd (by expanding the Elm Fork WTP if room for expansion is available) would be comparable to a new plant of the same size	Cost for conveyance is included in Project Conveyance Alternative costs	Cost for conveyance is included in Project Conveyance Alternative costs

Note (1): Distribution system costs (downstream of the WTP) are not included.
Note (2): The replacement of 102 mgd capacity at Elm Fork WTP is included in this figure. If this cost is excluded, the Present Value of the 50-year life-cycle cost is $335,572,000.

Modifications to Bachman WTP treatment process

- Biological filtration (currently being implemented);
- Additional ferric sulfate storage and feed facilities to meet desired TOC reduction (current enhanced coagulation improvements should meet these requirements); and
- Additional ozone generation capacity (approximately 200 lb/day) for manganese oxidation (existing plant ozonation facilities should be capable of providing this increased ozone requirement)

Proposed Southeast WTP

- Due to low alkalinity and elevated levels of TOC and manganese, the water would be more difficult to treat than the raw water from Scenario 1 (at Bachman WTP);
- Additional ferric sulfate addition would be required to meet desired TOC reduction; and

- Additional ozone would be required for manganese oxidation and due to increased demand from higher organic content in the water.

Proposed Joe Pool Lake WTP: raw water quality would be the same as that for Scenario 1 (at Bachman WTP) and would require the same treatment process and treatment requirements.

Mountain Creek Lake

The Mountain Creek Lake water right does not expressly authorize surface water to be stored in the reservoir from sources outside the Trinity River basin, nor does the water right preclude such storage. The Certificate of Adjudication also does not include special provisions, such as environmental flow requirements or conservation requirements for wholesale water users that would otherwise affect storage or transmission of water from outside the Trinity River basin in or through Mountain Creek Lake.

Based on the review of Joe Pool Lake, Lake Palestine, Cedar Creek Reservoir and Mountain Creek Lake water quality data, it is unlikely that routing water through Mountain Creek Lake to Bachman WTP will result in any significant drinking water quality concerns. These findings suggest that the option to route water through Mountain Creek Lake is a viable option with regards to drinking water quality.

9.2 Triple Bottom Line Business Case Evaluation

The project findings can be briefly summarized in terms of a comparison of positive or negative impacts of interconnection alternatives vs. baseline plans as shown in **Table 9-2** in a Triple Bottom Line Matrix.

Table 9-2
Triple Bottom Line Matrix
Comparison of Interconnection and Baseline Alternatives

Project Element	Economic	Environmental	Social
Capital Costs	+		
Life-cycle Cost	+		+
Water Treatment Implications	–		
Permitting/Constraints	+	–	
Environmental Water Quality		–	
Water Sharing and Timing, Redundancy, Flexibility	+	+	
Regional Cooperation and Future Water Supply	+	+	+
Ellis County Service			+

9.3 Recommendations

This initial feasibility study was tasked with assessing the "fatal flaws" and "business case" for a joint, integrated regional approach to water supply and raw water transmission. The findings of this study identify the economic, social and environmental potential of such a project, and clearly suggest that the prospect of interconnecting Lake Palestine through the TRWD system offers benefits that warrant further consideration.

Conceptual engineering and operational scenarios were analyzed in this effort; further analysis is needed to more fully develop how such a joint project would be planned, designed and operated to optimize economic and operational benefits to both systems. This subsequent effort must be initiated quickly due to impending supply constraints and is paramount to support development of institutional agreements and a financing strategy that will be required.

9.3.1 Conceptual Design Phase

It is recommended that TRWD and the City of Dallas proceed to a Conceptual Design Phase. The purpose of this second phase is to further develop:

- The conveyance alternatives (with more detailed hydraulic and operational analysis);
- The phasing potential of an integrated plan; and
- The cost analysis based on additional conceptual design details.

This will, in turn, support parallel organizational discussions regarding cost- and gain-sharing and the terms of a long-term institutional framework. At the conclusion of the conceptual design phase, both parties should have sufficient decision support to consider moving forward with detailed design and construction.

TRWD and the City of Dallas may, based upon the recommendations of this study, decide to further pursue joint interconnected raw water conveyance from Cedar Creek Reservoir, Richland–Chambers Reservoir and Lake Palestine. Despite a compressed timeframe for project development, careful additional study of the various issues mentioned above is recommended.

A conceptual design phase is recommended that would be jointly funded under an existing agreement between the City of Dallas and TRWD. Additional definition of infrastructure requirements at a conceptual level and further operational analysis will provide more detailed cost information. This report is a first step toward determining the viability of integrated water supply and transmission. The general OBJECTIVES of this planning and conceptual design process are:

1. Provide additional technical information to support the City of Dallas and TRWD and its primary wholesale customers with understanding project benefits and manage institutional and financial consequences;

2. Continue to advance project planning and development prior to detailed design to accommodate a 2015 delivery date;

3. Mitigate project cost and schedule variance; and

4. Ensure that the principles of the National Environmental Policy Act (NEPA) are considered early in the planning process to expedite all regulatory decisions, permitting and land acquisition.

Five **TASKS** have been identified to meet these objectives and will provide additional technical, operational, water quality, financial and contractual guidance to support decision making and project delivery. This information is needed so that that the City of Dallas, TRWD and its primary wholesale customers can make clear decisions regarding project costs, schedule, operations, and financing in support of a 2015 water delivery date:

1. Conceptual Design and Project Cost Analysis;

2. Environmental and Permitting Assessment (following NEPA principles);

3. Organizational and Financial Assessment;

4. Project Delivery, Schedule and Cost Management Plan; and

5. Delivery to DWU Water Treatment System.

Tarrant Regional Water District/ City of Dallas

SUMMARY REPORT
Amendment 2 of Phase 1 of the Raw Water Transmission System Integration Study

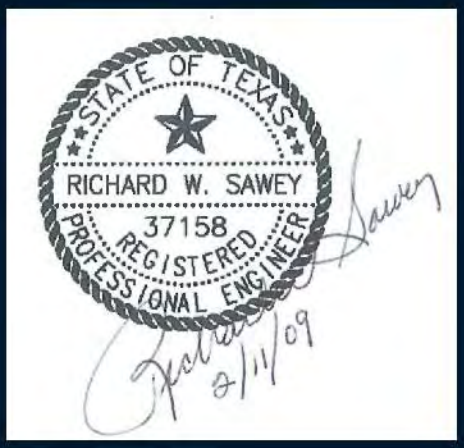
February, 2009

CDM

In Association with:
KBR and J. Stowe & Company

TARRANT REGIONAL WATER DISTRICT/ CITY OF DALLAS

SUMMARY REPORT
AMENDMENT 2 OF PHASE 1 OF THE RAW WATER TRANSMISSION SYSTEM INTEGRATION STUDY



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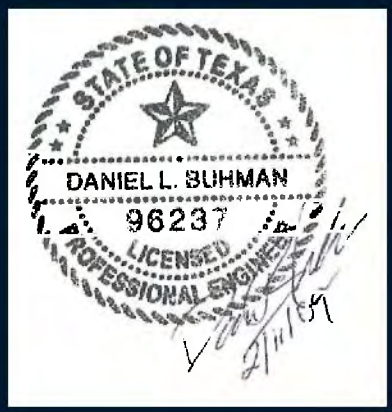

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Contents

Figures

Tables

Section 1
Introduction

1.1 Project Background

The Tarrant Regional Water District (TRWD) and the City of Dallas Water Utilities (DWU) have water rights or contracts involving 14 surface water reservoirs and operate raw water transmission facilities across North Central Texas. Dallas supplies treated and raw water to wholesale customers in Dallas, Collin, Denton, Ellis, and Kaufman Counties. TRWD supplies raw water and transmission services to Tarrant and 8 other counties in Region C and Johnson County in the Brazos G Region. TRWD and DWU provide drinking water to 4.4 million people, a population that is expected to double in the next 50 years.

Current population projections and water demand trends included in the 2006 Region C Regional Water Plan and the 2005 Update of the Dallas Long Range Water Supply Plan, as illustrated in **Figures 1-1a** and **1-1b**, will soon be updated with new water management strategy recommendations. These updates will include connecting Lake Palestine to the DWU water system, completion of the TRWD constructed wetlands, and construction of TRWD's Third East Texas Pipeline from Cedar Creek and Richland-Chambers Reservoirs.

The geographic proximity of Lake Palestine to the existing TRWD water supplies and raw water transmission facilities at Cedar Creek and Richland-Chambers Reservoirs (as shown in **Figure 1-2**) and the location, timing, and volumes of water demands prompted DWU and TRWD to discuss the opportunity to explore the feasibility of an integrated approach to bring additional water into the Dallas and Tarrant Regional Water District service areas.

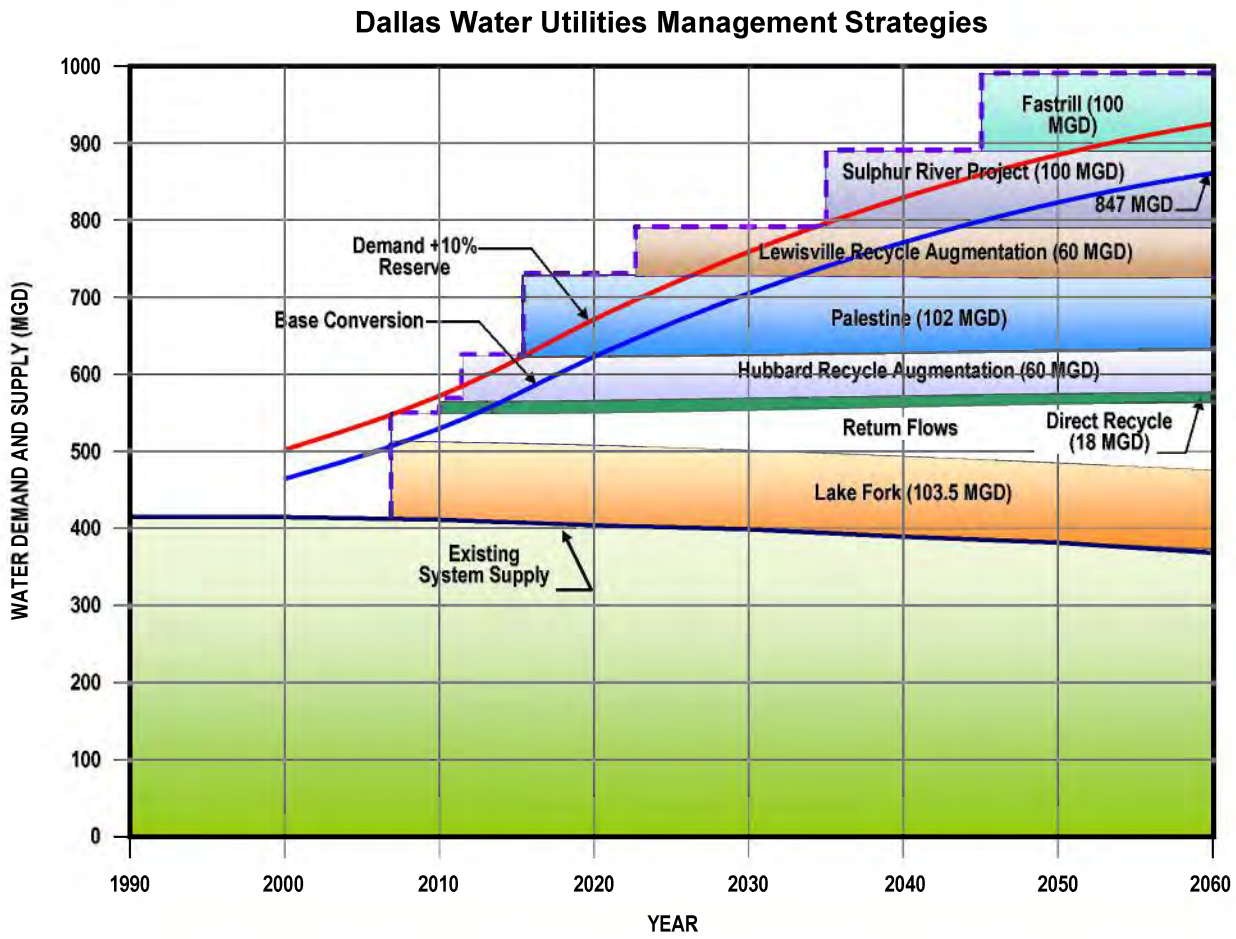

Figure 1-1a
DWU Water Management Strategies
(Figure from December 6, 2006 City Council Briefing)

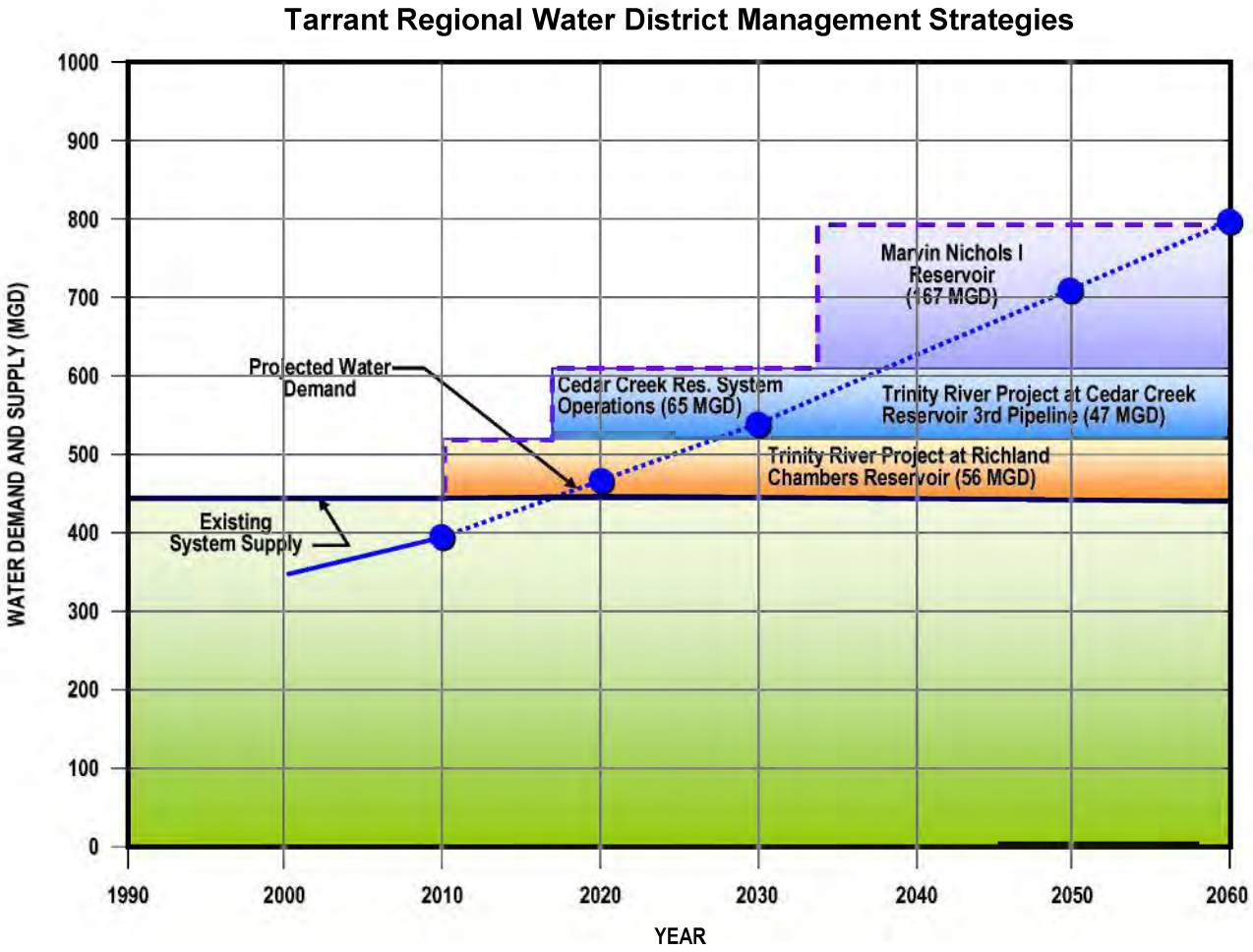

Figure 1-1b
TRWD Water Management Strategies
(based on 2006 Region C Water Plan numbers)

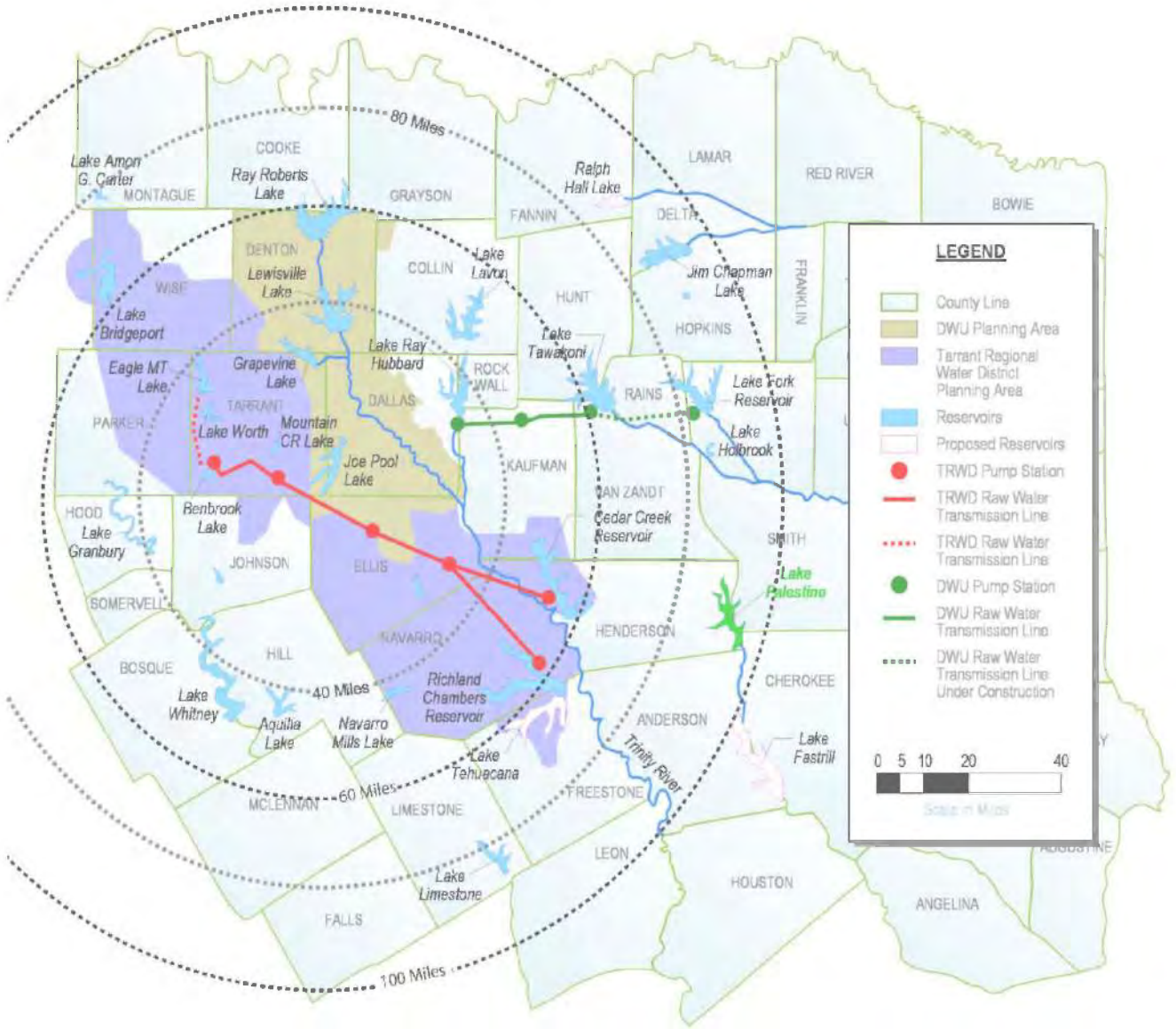

Figure 1-2
Vicinity Map

This report documents ongoing regional plan updates involving the initial project viability assessment and business case evaluation of integrating the TRWD and DWU raw water transmission systems, **Figure 1-2**.

1.2 Project Scope and Purpose

This report documents the results of Amendment 2 to the Phase 1 Project Viability Assessment and Business Case Evaluation. The purpose of the work authorized in Amendment 2 is to:

1. Provide additional analysis on, and refinement to, two interconnected conveyance alternatives (developed in Phase I: the Interconnected Third Pipeline and Interconnected Southern Pipeline) and recommend **a single alternative for continued evaluation**.

2. Prepare a **Project Development Plan** to identify the institutional, political, financial, and policy opportunities and barriers for a project of this magnitude and complexity. These project development issues include governance, contracting, project management, design, construction, operation, and financial issues such as cost- and gain-sharing, as well as water sharing, etc.; and

3. Developing a **Project Delivery Schedule** to guide the design and construction process.

In short, this planning and analysis will provide:

- **Decision-making support with regard to a potential contractual relationship between TRWD and the City of Dallas for joint raw water transmission;**

- **Information regarding a path forward for implementing a joint project (tasks and schedule); and**

- **A narrower range of options to be considered by recommending one interconnected conveyance alternative for further analysis and development.**

This information will lead to a decision between the two joint conveyance alternatives as shown in Table 1-1 and Figure 1-3.

Table 1-1
Project Conveyance Alternatives

Alternative	Description
1	**Interconnected Third Pipeline** (upsized as compared to the baseline condition) with connection of Lake Palestine to Cedar Creek Reservoir and delivery to DWU near Joe Pool Lake and TRWD's customers through the Third Pipeline
2	**Interconnected "Southern Pipeline"** - Lake Palestine delivered to the Lake Benbrook pipeline via a pipeline route to the south of the TRWD Third Pipeline route. Delivery to DWU near Joe Pool Lake and TRWD's customers through connections to the existing system and the Lake Benbrook pipeline.

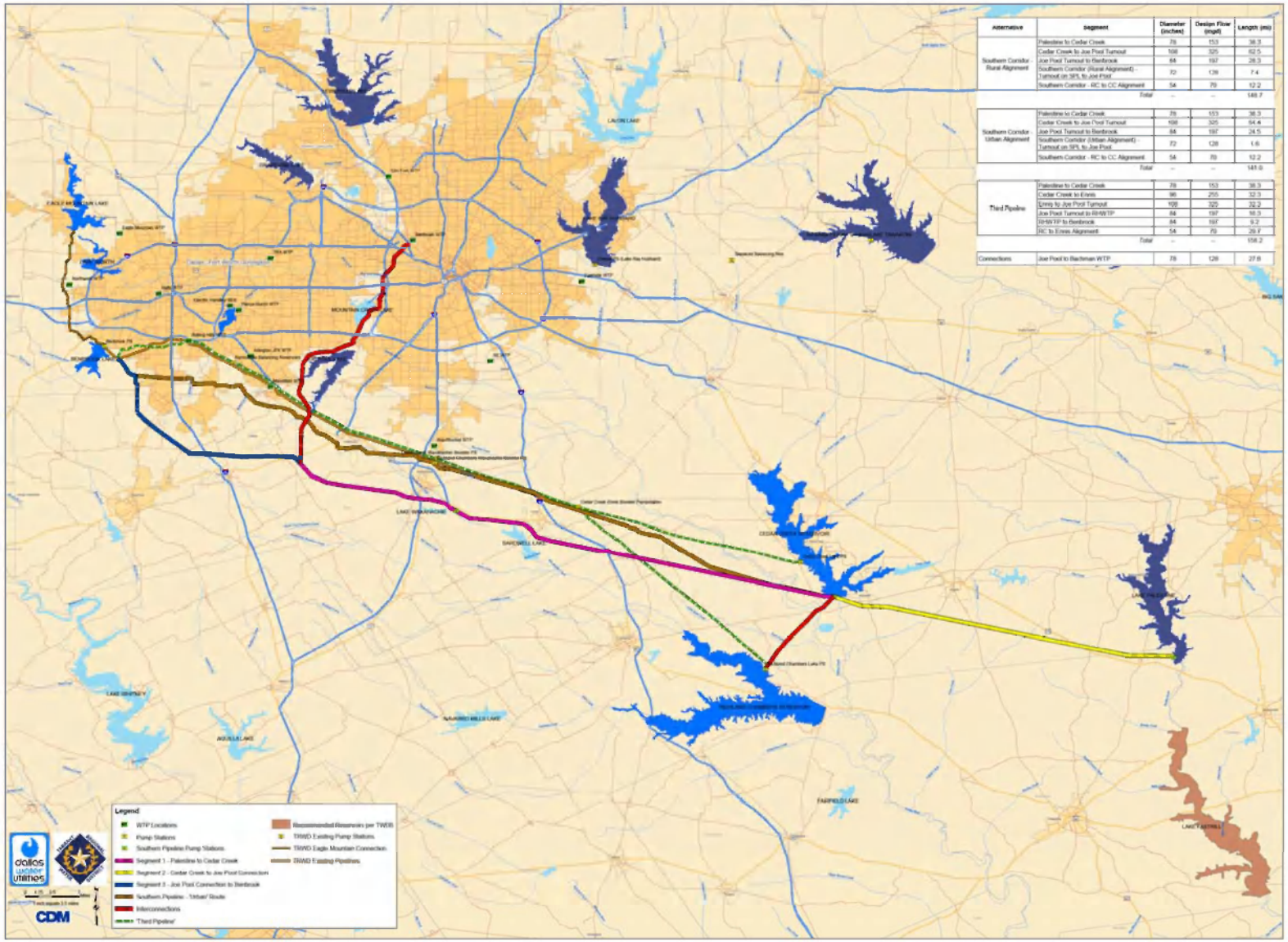

Figure 1-3
Study Area Limits

Section 2
Criteria and Standards

2.1 Purpose

The purpose of developing criteria and standards was to establish standard conditions for facilities, delivery operations, and cost analysis. Criteria and standards set modeling and cost variables at reasonable values adequate for this level of analysis. These standards are based on a technical workshop involving TRWD, the City of Dallas, and the consulting team and a technical memorandum reviewed by all participants. Standards were set based on owner and engineering judgment, previous analysis of this type, data from similar conveyance projects, and consensus among the project team.

2.2 Facilities and Delivery Operations

- Point of delivery:
  - **Third Pipeline –** need to add 150 mgd (plus 1.25 peak) from Rolling Hills WTP (RH WTP) to Lake Benbrook (BB) going west. Don't need to add any capacity from BB to RH WTP going east but could use that new pipeline to pump back for flexibility. So in this scenario, need new pipeline.
  - **Southern Pipeline (SPL) –** add zero going west and zero going east, so no new pipeline from RH WTP to BB. Connect the SPL at the end of the Benbrook pipeline tunnel, which is at the junction where the Benbrook connection splits to the Benbrook Outlet and the BB lake pump station (BB1). From this connection, the 150x1.25 needs to go west to BB2 and/or the Benbrook Outlet.
- Transmission system criteria.

Table 2-1
Transmission Criteria

Transmission Criteria	Integrated System
Maximum Working Pressure (psi)	200*
Peak Pipeline Velocity (ft/s)	8
Peaking Factor (Peak Q/Avg Q)	1.25 Exception: For Palestine to Cedar Creek, use a 1.5 peaking factor.
Booster Pump Station Ground Storage	2.5 hours at Peak Capacity
Balancing Storage at Pressure/Gravity Transition	5% of Rated Capacity

*Note: 200 psi is a reasonable limit for most plant's capabilities in spiral welded pipe of 120" diameter. The use of 50 ksi steel or rolled plate pipe (can pipe) would allow pressures of 260 to 375 psi or more.

- **Table 2-2** was supplied by TRWD to establish supply source and transmission system capacities:

Table 2-2
Permitted Reservoir Supplies and Related Transmission Pipeline Capacities

Reservoir System	Reservoir Supply Capacities				Transmission Pipeline Capacities									
	Storage Firm/Permit		Storage 2010 Safe		Existing Pipelines Maximum		Combined Pipelines Normal Day		Combined Pipelines Peak Day		New Joint Pipeline Normal Day		New Joint Pipeline Peak Day	
	Acre/Ft	MGD	Acre/Ft	MGD	Acre/Ft	MGD	Acre/Ft	MGD	Acre/Ft	MGD	Acre/Ft	MGD	Acre/Ft	MGD
CEDAR CREEK														
Reservoir	175,000	156	152,783	136	142,268	127	175,000	156	218,750	195	32,732	29	76,482	68
Wetlands	52,500	47	52,500	47	0	0	52,500	47	65,625	59	52,500	47	65,625	59
Sub-Total	**227,500**	**203**	**205,283**	**183**	**142,268**	**127**	**227,500**	**203**	**284,375**	**254**	**85,232**	**76**	**142,107**	**127**
RICHLAND-CHAMBERS														
Reservoir	210,000	187	188,444	168	275,574	246	210,000	187	275,574	246	-65,574	-59	0	0
Wetlands	63,000	56	63,000	56	0	0	63,000	56	78,750	70	63,000	56	78,750	70
Sub-Total	**273,000**	**244**	**251,444**	**224**	**275,574**	**246**	**273,000**	**244**	**354,324**	**316**	**-2,574**	-2	**78,750**	**70**
LAKE PALESTINE														
Reservoir	114,337	102	112,080	100	0	0	114,337	102	142,921	128	114,337	102	142,921	128
Wetlands	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sub-Total	**114,337**	**102**	**112,080**	**100**	**0**	**0**	**114,337**	**102**	**142,921**	**128**	**114,337**	**102**	**142,921**	**128**
GRAND TOTAL	**614,837**	**549**	**568,807**	**508**	**417,842**	**373**	**614,837**	**549**	**781,620**	**698**	**196,995**	**176**	**363,778**	**325**

Conditions and Limitations --

1. Existing Pipelines Capacities = Total CC and RC pipeline capacity (not cross-connected) from lake pump stations to RH-WTP.
2. Joint Pipelines Capacities = Total of Existing CC and RC pipeline capacities plus new joint pipeline capacity (not cross-connected).
3. New Joint Pipeline Capacities = Difference of existing and combined pipeline capacities.
4. The 1.25 peaking factor is applied to CC and RC wetlands.
5. The 1.25 peaking factor is applied for Palestine water from CC and RC reservoirs to the DWU delivery point (1.5 from Pal to CC/RC)
6. Capacities for existing TRWD and new joint pipelines apply only to pipelines originating from the CC and RC reservoirs.

Results --

1. New pipeline from CC and RC reservoirs to DWU delivery point = 325 MGD 363,778 Acre/Ft
2. New pipeline from DWU delivery point on to RH-WTP or Benbrook = 197 MGD 220,857 Acre/Ft

Table 2-3
Additional Pipeline Flow Capacities

	Existing System Peak Capacity @ 8fps (mgd)
Kennedale to RH WTP	127 + 228 = 355, 225 reverse flow
RH WTP to Benbrook	110 Gravity, 200 with RHBPS, 225 reverse flow

*Note: At 8 fps capacity is 146 mgd. Actual system constraints limit this value to 127 mgd.
**Note: Used 244 in Phase 1 Ops Model
†Note: 1.25 peaking factor

- Use Safe yield for planning, Firm yield for operations
  - Firm yield – maximum yield without a shortage of supply; reservoir would be empty at end of historical critical period.
  - Safe yield – maximum yield leaving a minimum storage equivalent to one year's supply in the reservoir at end of historical critical period.

Table 2-4
Permitted Yield

Storage Facility	Annual Permit/Contract Yield (ac-ft/yr)
Lake Palestine	114,337
Richland-Chambers Reservoir	210,000
Richland-Chambers Constructed Wetlands	63,000
Cedar Creek Reservoir	175,000
Cedar Creek Constructed Wetlands	52,500
Lake Benbrook	72,500
West Fork Trinity River (Eagle Mountain Lake, Lake Worth and Lake Bridgeport)	100,000 unless lakes are at <50% combined capacity, in which case 46,000

- Richland Chambers = 210,000 + 63,000 wetlands for a total of 273,000 ac-ft/yr. Wetlands are 100% operational in 2018. **Flow from Lake Palestine will be considered as additional available yield.**
- Cedar Creek = 175,000 + 52,500 wetlands for a total of 227,500 ac-ft/yr. Wetlands are 100% operational in 2018. **Flow from Lake Palestine will be considered as additional available yield.**

- Capacity of Kennedale Balancing Reservoir was 300 million gallons. They were recently relined and soil cement was added over 100% of area. Now 250 mg < capacity < 300 mg.

2.2.1 System Demands

- The TRWD supply from the combined system will be timed and quantified using the following guidelines:
  - **Table 2-5** (Data source: TRWD) specifies the timing and quantity of TRWD's customer demands.
  - It is assumed that the constructed wetlands (both Cedar Creek and Richland-Chambers) will be on-line before 2018
  - An appropriate factor of safety is applied by using safe yield for reservoir supply projections.

Table 2-5
Annual Average Demand by Decade and Withdrawal Location

	ANNUAL AVERAGE DEMAND (mgd)				
	2020	**2030**	**2040**	**2050**	**2060**
Mansfield WTP	13	17	21	25	29
Arlington JFK WTP	46	49	56	63	69
Arlington Pierce-Burch WTP	38	47	53	59	66
Rolling Hills WTP**	76	81	89	98	106
TRA Mosier Valley WTP	48	59	69	80	90
Eagle Mountain WTP*	65	80	95	110	127
Northwest WTP*	13	21	30	41	53
Holly WTP*	50	47	43	39	35
Fort Worth Southwest WTP**	10	13	15	18	20
Ellis County***	47	60	74	88	104
Cedar Creek Local W/D	4	5	6	7	8
Richland Chambers Local W/D	4	4	5	5	5
Lake Arlington Local WD	2	2	3	3	3
Benbrook Local W/D	4	6	7	8	9
Lake Worth Local W/D	4	4	4	4	4
Eagle Mountain Local W/D	2	3	3	4	4
Lake Bridgeport Local W/D	6	8	8	9	10
Full TRWD Demand	432	506	581	661	742
DWU Demand	0	55	102	102	102 ?

*Full demands for Holly WTP, Eagle Mountain WTP, and Northwest WTP are listed. West Fork will supply up to its permitted limit, and remainder of demand is on integrated system.
**Demand on Rolling Hills WTP reduced by estimated amount of Southwest WTP based on City of Fort Worth Water Master Plan, 2005
***Ellis County Gross Demand from the "Four County Study" currently underway.

- The Dallas supply from the integrated system will be timed and quantified using the following guidelines:
  - **Table 2-6** (Data source: City of Dallas Water Utilities 2005 Update - Long Range Water Supply Plan, December 2005 unless otherwise noted) specifies the timing and quantity of Dallas' need for additional supply.
  - **Table 2-6** does not show 2015 as the forecast date for a new supply source due to the pending increase in Lake Ray Hubbard permitted yield.
  - An appropriate factor of safety is applied when determining the date at which new water supply sources will be required.
  - This study assumes that Dallas does not intend to base load its system with the new supply from the integrated system. Therefore, demand on the integrated system will increase over time, resulting in potential phasing opportunities..

2.3 Cost Analysis

- Pipeline material assumed for the purposes of the cost analysis: Steel in urban settings, PCCP in rural
- Year for basis of cost: 3rd quarter 2008.
- Assumed transmission pipeline depth of cover is 4' in rural areas and 5' in urban areas
- Assume sufficient right-of-way purchase for two pipelines (one for a future line). Assume 140' permanent easement and 0' temporary easement.
- The cost estimate assumes an "Urban" classification for all pipelines within City limits. Urban areas were identified from areal maps and GIS. Urban areas were divided into "Low Urban", "Medium Urban", and "Heavy Urban", where varying production rates were assumed for each classification. In undeveloped urban areas or areas that are lightly populated (low density), a Low Urban rating was assigned. These areas have few visible surface constraints but may require relocation and/or protection of existing underground utilities since the work is within populated areas. A Medium Urban rating was assigned to portions of the alignment in areas having a moderate level of residential, commercial and industrial development. A Heavy Urban rating was assigned to densely developed areas that will require a large amount of surface restoration and likely involve a high degree of utility relocations
- To make an "apples to apples" comparison with the Integrated Southern Pipeline (which includes ROW for two pipelines), assume in the Integrated Third Pipeline alternative the purchase of additional permanent ROW for one future pipeline.

Because there is no room adjacent to the existing ROW, this new permanent easement will be in a southern route. Therefore, this analysis will calculate cost for purchase of ROW sufficient for 2 additional pipelines (140') regardless of project alternative (Southern or Third Pipeline).

- Per Region C 2006 Water Plan, price per acre of rural right-of-way was $3,000/acre for permanent and $1,500 for temporary; and the price per acre of urban right-of-way was $30,000/acre. Based on recent costs incurred by TRWD and Dallas, these will be modified to $15,000/acre rural and $70,000/acre urban.

- Engineering, legal services, environmental-archeological studies, mitigation, permitting, and contingencies are accounted for as specified in Appendix U of the Region C 2006 Water Plan:

    - Environmental-archeological studies, mitigation, permitting, and contingencies are 1% of the capital construction cost.

    - 30% is added to pipeline elements and 35% to other components to cover engineering, legal, and contingency

Table 2-6
Supply-Demand Table: City of Dallas Water Utilities 2005 Update - Long Range Water Supply Plan, December 2005

				Demand (MGD) Met by:															
Year	Population	Demand MGD[1,2]	Conser-vation	Direct Reuse	Lake Ray Hubbard	Lake Ray Hubbard Additional Yield	Reuse in Hubbard[5]	Elm Fork ROR (CF75)	Elm Fork OverDraft 5414	Elm Fork Reuse[6]	Grape-vine[7]	Lew-isville	Lew-isville Reuse[8]	Lake Tawakoni	Ray Roberts	Lake Fork[9]	Lake Palestine	Total	Balance
2010	2,770,001	529.36	15.7	18.3	80.1	--	28.1	10.0	9.0	15.3	10.0	85.9	8.9	163.9	56.2	102.5	–	**603.9**	74.5
2011	2,817,581	537.04	16.2	18.3	80.1	--	28.5	10.0	9.0	15.7	10.0	85.9	9.6	163.8	56.2	102.5	–	**605.8**	68.7
2012	2,865,161	544.73	16.7	18.3	80.1	--	28.8	10.0	9.0	16.1	10.0	85.9	10.4	163.7	56.2	102.5	–	**607.6**	62.9
2013	2,912,741	552.41	17.2	18.3	80.1	--	29.2	10.0	9.0	16.5	10.0	85.9	11.1	163.5	56.2	102.5	–	**609.5**	57.1
2014	2,960,321	560.10	17.7	18.3	80.1	--	29.5	10.0	9.0	16.8	10.0	85.9	11.9	163.4	56.2	102.5	–	**611.4**	51.3
2015	3,007,902	567.78	18.2	18.3	80.1	--	29.9	10.0	9.0	17.2	10.0	85.9	12.7	163.3	56.2	102.5	–	**613.3**	45.5
2016	3,055,482	575.46	18.7	18.3	80.1	--	30.3	10.0	9.0	17.6	10.0	85.9	13.4	163.2	56.2	102.5	–	**615.2**	39.7
2017	3,103,062	583.15	19.2	18.3	80.1	--	30.6	10.0	9.0	18.0	10.0	85.9	14.2	163.1	56.2	102.5	–	**617.1**	33.9
2018	3,150,642	590.83	19.7	18.3	80.1	--	31.0	10.0	9.0	18.4	10.0	85.9	14.9	162.9	56.2	102.5	–	**618.9**	28.1
2019	3,198,222	598.52	20.2	18.3	80.1	--	31.3	10.0	9.0	18.8	10.0	85.9	15.7	162.8	56.2	102.5	–	**620.8**	22.3
2020	3,245,802	606.20	20.7	18.3	80.1	--	31.7	10.0	9.0	19.2	10.0	85.9	16.4	162.7	56.2	102.5	–	**622.7**	16.5
2021	3,284,012	614.38	21.1	18.3	80.1	--	32.1	10.0	9.0	19.5	10.0	85.9	17.0	162.6	56.2	102.5	–	**624.3**	9.9
2022	3,322,222	622.57	21.6	18.3	80.1	--	32.5	10.0	9.0	19.7	10.0	85.9	17.6	162.5	56.2	102.5	–	**625.9**	3.3
2023	3,360,432	630.75	22.0	18.3	80.1	--	32.8	10.0	9.0	20.0	10.0	85.9	18.2	162.3	56.2	102.5	102.0	**729.4**	98.7
2024	3,398,642	638.94	22.5	18.3	80.1	--	33.2	10.0	9.0	20.3	10.0	85.9	18.8	162.2	56.2	102.5	102.0	**731.0**	92.1
2025	3,436,852	647.12	22.9	18.3	80.1	--	33.6	10.0	9.0	20.6	10.0	85.9	19.4	162.1	56.2	102.5	102.0	**732.6**	85.5
2026	3,475,061	655.30	23.3	18.3	80.1	--	34.0	10.0	9.0	20.9	10.0	85.9	20.0	162.0	56.2	102.5	102.0	**734.2**	78.8
2027	3,513,271	663.49	23.8	18.3	80.1	--	34.4	10.0	9.0	21.2	10.0	85.9	20.6	161.9	56.2	102.5	102.0	**735.7**	72.2
2028	3,551,481	671.67	24.2	18.3	80.1	--	34.7	10.0	9.0	21.4	10.0	85.9	21.2	161.7	56.2	102.5	102.0	**737.3**	65.6
2029	3,589,691	679.86	24.7	18.3	80.1	--	35.1	10.0	9.0	21.7	10.0	85.9	21.8	161.6	56.2	102.5	102.0	**738.9**	59.0
2030	3627901	688.04	25.1	18.3	80.1	--	35.5	10.0	9.0	22.0	10.0	85.9	22.3	161.5	56.2	102.5	102.0	**740.4**	52.4
2031	3,661,218	694.06	25.6	18.3	80.1	--	35.8	10.0	9.0	22.0	10.0	85.9	22.9	161.4	56.2	102.5	102.0	**741.7**	47.6
2032	3,694,534	700.07	26.0	18.3	80.1	--	36.1	10.0	9.0	22.0	10.0	85.9	23.5	161.3	56.2	102.5	102.0	**742.9**	42.9
2033	3,727,851	706.09	26.5	18.3	80.1	--	36.5	10.0	9.0	22.0	10.0	85.9	24.1	161.1	56.2	102.5	102.0	**744.2**	38.1
2034	3,761,168	712.10	26.9	18.3	80.1	--	36.8	10.0	9.0	22.0	10.0	85.9	24.7	161.0	56.2	102.5	102.0	**745.5**	33.4
2035	3,794,485	718.12	27.4	18.3	80.1	--	37.1	10.0	9.0	22.0	10.0	85.9	25.3	160.9	56.2	102.5	102.0	**746.7**	28.6
2036	3,827,801	724.13	27.9	18.3	80.1	--	37.4	10.0	9.0	22.0	10.0	85.9	25.9	160.8	56.2	102.5	102.0	**748.0**	23.8

Table 2-6 (cont.)
Supply-Demand Table: City of Dallas Water Utilities 2005 Update - Long Range Water Supply Plan, December 2005

				Demand (MGD) Met by:														
Year	Population	Demand MGD[1 2]	Conser-vation	Direct Reuse	Lake Ray Hubbard	Lake Ray Hubbard Additional Yield	Reuse in Hubbard[5]	Elm Fork ROR (CF75)	Elm Fork OverDraft 5414	Elm Fork Reuse[6]	Grape-vine[7]	Lew-isville	Lew-isville Reuse[8]	Lake Tawakoni	Ray Roberts	Lake Fork[9]	Lake Palestine	Total	Balance
2037	3,861,118	730.15	28.3	18.3	80.1	–	37.7	10.0	9.0	22.0	10.0	85.9	26.5	160.7	56.2	102.5	102.0	**749.2**	19.1
2038	3,894,435	736.16	28.8	18.3	80.1	–	38.1	10.0	9.0	22.0	10.0	85.9	27.1	160.5	56.2	102.5	102.0	**750.5**	14.3
2039	3,927,751	742.18	29.2	18.3	80.1	–	38.4	10.0	9.0	22.0	10.0	85.9	27.7	160.4	56.2	102.5	102.0	**751.7**	9.5
2040	3961068	748.19	29.7	18.3	80.1	–	38.7	10.0	9.0	22.0	10.0	85.9	28.3	160.3	56.2	102.5	102.0	**753.0**	4.8
2041	3,990,335	753.43	30.2	18.3	80.1	–	38.8	10.0	9.0	22.0	10.0	85.9	28.9	160.2	56.2	102.5	102.0	**754.0**	0.5
2042	4,019,601	758.66	30.6	18.3	80.1	–	38.8	10.0	9.0	22.0	10.0	85.9	29.5	160.0	56.2	102.5	102.0	**755.0**	(3.7)
2043	4,048,868	763.90	31.1	18.3	80.1	–	38.9	10.0	9.0	22.0	10.0	85.9	30.1	159.9	56.2	102.5	102.0	**756.0**	(7.9)
2044	4,078,134	769.14	31.6	18.3	80.1	–	39.0	10.0	9.0	22.0	10.0	85.9	30.6	159.8	56.2	102.5	102.0	**757.0**	(12.2)
2045	4,107,401	774.38	32.1	18.3	80.1	–	39.1	10.0	9.0	22.0	10.0	85.9	31.2	159.7	56.2	102.5	102.0	**758.0**	(16.4)
2046	4,136,668	779.61	32.5	18.3	80.1	--	39.1	10.0	9.0	22.0	10.0	85.9	31.8	159.5	56.2	102.5	102.0	**759.0**	(20.6)
2047	4,165,934	784.85	33.0	18.3	80.1	--	39.2	10.0	9.0	22.0	10.0	85.9	32.4	159.4	56.2	102.5	102.0	**760.0**	(24.9)
2048	4,195,201	790.09	33.5	18.3	80.1	--	39.3	10.0	9.0	22.0	10.0	85.9	33.0	159.3	56.2	102.5	102.0	**761.0**	(29.1)
2049	4,224,467	795.32	33.9	18.3	80.1	--	39.3	10.0	9.0	22.0	10.0	85.9	33.6	159.1	56.2	102.5	102.0	**762.0**	(33.3)
2050	4253734	800.56	34.4	18.3	80.1	--	39.4	10.0	9.0	22.0	10.0	85.9	34.2	159.0	56.2	102.5	102.0	**763.0**	(37.6)
2051	4,278,959	805.25	34.9	18.3	80.1	--	39.4	10.0	9.0	22.0	10.0	85.9	34.2	158.9	56.2	102.5	102.0	**763.4**	(41.9)
2052	4,304,184	809.94	35.4	18.3	80.1	--	39.4	10.0	9.0	22.0	10.0	85.9	34.2	158.8	56.2	102.5	102.0	**763.8**	(46.2)
2053	4,329,408	814.63	35.9	18.3	80.1	--	39.4	10.0	9.0	22.0	10.0	85.9	34.2	158.6	56.2	102.5	102.0	**764.1**	(50.5)
2054	4,354,633	819.32	36.4	18.3	80.1	--	39.4	10.0	9.0	22.0	10.0	85.9	34.2	158.5	56.2	102.5	102.0	**764.5**	(54.8)
2055	4,379,858	824.02	36.9	18.3	80.1	--	39.4	10.0	9.0	22.0	10.0	85.9	34.2	158.4	56.2	102.5	102.0	**764.9**	(59.1)
2056	4,405,083	828.71	37.4	18.3	80.1	--	39.4	10.0	9.0	22.0	10.0	85.9	34.2	158.3	56.2	102.5	102.0	**765.3**	(63.4)
2057	4,430,308	833.40	37.9	18.3	80.1	--	39.4	10.0	9.0	22.0	10.0	85.9	34.2	158.2	56.2	102.5	102.0	**765.7**	(67.7)
2058	4,455,532	838.09	38.4	18.3	80.1	--	39.4	10.0	9.0	22.0	10.0	85.9	34.2	158.0	56.2	102.5	102.0	**766.0**	(72.0)
2059	4,480,757	842.78	38.9	18.3	80.1	--	39.4	10.0	9.0	22.0	10.0	85.9	34.2	157.9	56.2	102.5	102.0	**766.4**	(76.4)
2060	4505982	847.47	39.4	18.3	80.1	--	39.4	10.0	9.0	22.0	10.0	85.9	34.2	157.8	56.2	102.5	102.0	**766.8**	(80.7)

Data source: City of Dallas Water Utilities 2005 Update - Long Range Water Supply Plan, December 2005 unless otherwise noted.

[1]Irving's demand is reduced by Irving's Supply form Lake Chapman (39 MGD)

[2]Upper Trinity Regional Water District' demands are reduced by UTRWD's Lake Chapman and Reuse Supplies (up to 42 MGD)

[3]Assumes permitted use for Lake Ray Hubbard (CA-08-2462).

[4]Note not used

[5]Wastewater discharge projections provided by NTMWD

[6]Return flows from City of Lewisville WWTP and City of Flower Mound WWTP

[7]Yield developed by staff

[8]Wastewater discharge projections provided by NTMWD reduced 5% to account for Denton's water right.

[9]Lake Fork supply reduced to account for TXU exercising its option.

Section 3
Integrated Conveyance Alternatives

3.1 Purpose

The purpose of on-going analysis on integrated conveyance alternative corridors is to compare the Southern Pipeline and Third Pipeline corridor options and recommend a preferred option for connecting Lake Palestine and additional Cedar Creek and Richland-Chambers Reservoir water to the Dallas-Fort Worth Metroplex.

To make this comparison, the Southern Pipeline corridor was first refined to minimize overall capital cost by shortening its length while retaining other desirable characteristics. This refinement was necessary because the initial corridor selected at the beginning of Phase 1 was a "bounding" option, meant to bracket cost implications with both a maximum and minimum cost option. Therefore, the original corridor was the longest (farthest south of the existing TRWD right-of-way) making this an expensive alternative. While this provided information needed only to decide if system integration was feasible under a "worst-case" cost scenario, clearly further refinement would lower the estimated cost. The result of the initial analysis was that "yes", system integration is feasible and beneficial; therefore, this analysis refines the Southern Pipeline corridor to make a more direct cost comparison to the Third Pipeline corridor to support selection of a single conveyance alternative for further analysis.

Second, both corridors were further refined by more accurately categorizing the density of urbanization along the pipeline and in terms of cost. Cost analyses are documented in Section 7.

Third, the implications of power supply redundancy were considered. The existing TRWD transmission system utilizes booster pump stations at Ennis and Waxahachie. If the Third Pipeline corridor alternative is selected, existing pump stations would be expanded and power supply delivery would not diversify. However, if the Southern Pipeline alternative is selected, new booster pump stations would be required. This analysis considered the power supply to these pump stations (as compared to the existing stations) and what power supply redundancy could exist due to new booster station locations on the electrical grid

Athough the original intent of on-going analysis was to refine the Southern Pipeline to one conveyance alternative, two options for this corridor emerged – a southern pipeline alternative through mostly rural areas and an alternative through more urbanized areas. Therefore, two Southern Pipeline corridor alternatives and one Third Pipeline alternative are described below. This section provides a narrative description of the corridor selection, tables documenting pipeline length and size (as determined by hydraulic analysis and criteria described in other sections), and a description of the power supply redundancy research; Appendix A contains more detailed mapping of the pipeline corridor alternatives.

3.2 Southern "Urban" Pipeline Corridor

The following list provides a narrative description of the Southern "Urban" Pipeline Corridor.

- From Palestine to Cedar Creek Reservoir is almost a straight line. Deviations were made to avoid one high spot at the beginning and an urban area, but otherwise it is the shortest route to the Cedar Creek dam, where TRWD has discussed siting its next lake pump station.

- From Cedar Creek, the line swings a bit farther west to avoid multiple crossings of the Trinity River and forested wetland areas. An added benefit is picking up some existing utility ROW's for potential simplification of easement acquisition.

- This existing utility ROW is departed from at FM 85. The line skirts west to avoid what appear to be some ponds and then follows FM 85 until the road is flanked on both sides by homes. These are avoided by heading to the north side of the homes and the route then continues NW through rural areas.

- At Ennis PS, the new line is only about 2,000 feet south of the existing PS.

- This path continues until the north end of Ennis, where the corridor splits into two possibilities – an **'Urban'** Corridor and a **'Rural'** Corridor. The 'urban' corridor attempts to stay as far north as possible and pick its way through urban areas by following existing utilities (like power lines) and roads. The 'rural' corridor tries to stay south of urbanization, though this is not completely possible, and pass through less dense urban areas.

- The north end of Ennis is planned in the Ennis future land use plan for Low Density Residential.

- At I-45, the new line is only about 1,000' south of the existing pipelines because the north end of Ennis is much less densely urbanized.

- The line continues to parallel the existing lines, though a bit farther south (~2,000') until it reaches the NE end of Waxahachie. At this point, the corridor cuts due west in between some urban development, then NW through some open fields and then more due west to the crossing at I-35E. These turns are only made to avoid existing urbanization. However, future land use along the I-35, Highway 77, 287 triangle is commercial, industrial, and retail. Depending on the time of development, this may be a difficult area to cross.

- After I-35E there is a turn to the NW to get to the north side of some development, then the line cuts almost due west and runs in Marshall road and then continues to run past the south end of Midway airport.

- This continues past 287 until the line cuts NW parallel to a natural gas gathering line that runs past Watson Lake. It turns west at Mount Zion road and follows this to stay south of 287.

- The area south of 287 is urbanizing into three zones per the Midlothian future land use plan (NCTCOG source). The area this line would pass through is planned for Country Module and Suburban Module development, both heavily residential and only really differing in lot size and multi-family housing.

- At the west end of some existing development, the line turns due north until it meets an Atmos pipeline, then it turns NW and runs somewhat parallel to 287. This area of Midlothian is also planned for development – industrial to the area just west of where the line turns due north, and 'regional' land use then more suburban and then 'village' module land use types. This area may be very difficult to cross depending on when it is developed. If it needs to be avoided, the line should not turn due north but should continue west through the 'industrial' area until it gets west of 67 some distance. When the line runs somewhat parallel to 287, it is running in the Old Fort Worth road, which has structures (not dense) on the south side but not the north (as of early 2007).

- The line continues parallel to 287, at one point within 1,000', cuts due west to follow St. Paul Rd for a short distance, then continues jogging NW and west to avoid existing urban developments.

- Now at the south end of Midlothian, the line continues west until it reaches a Southwestern Gas Pipeline ROW and then turns more north and follows this ROW until reaching FM 1187 (Rendon Bloodworth Road). This is where the line snakes its way west, along the road.

- 8,700' east of Spinks airport, there are two choices. One is to continue along FM 1187, which in truth is not large enough for a 140' ROW. The other is to follow a Barnett Gathering, LP line to the north until reaching a dual power line ROW, which could be followed west. At the I-35W crossing, the power line easement is 4,200' north of the FM 1187 crossing.

- If FM 1187 is used past I-35W (as we head west), it continues to be followed as it turns a bit south and then continues west until just east of FM 1902 (Old Granbury Road). If the power line ROW is used, it stays farther north and then turns north at the same location east of FM 1902, but 9,900' to the north of the point where the FM 1187 following run turns north.

- The line runs due north until terminating at the end of the Benbrook connection tunnel.

Table 3-1
Southern "Urban" Corridor Sizing, Flow, Length

Segment	Diameter (inches)	Design Flow (mgd)	Length (mi)
Palestine to Cedar Creek	78	153	38.3
Cedar Creek to Joe Pool Turnout	108	325	64.4
Joe Pool Turnout to Benbrook	84	197	24.5
Interconnection to Joe Pool Vicinity	72	128	1.6
Richland-Chambers to Cedar Creek Interconnection	54	70	12.2
Total	--	--	141.0

3.3 Southern "Rural" Pipeline Corridor

- From Palestine to Cedar Creek Reservoir is almost a straight line. Deviations were made to avoid one high spot at the beginning and an urban area, but otherwise it is the shortest route to the Cedar Creek dam, where TRWD has discussed siting its next lake pump station.

- From Cedar Creek, the line runs in nearly a direct path to the south side of Ennis and then runs on the south side of Ennis, very close to the eastern edge of Bardwell Lake.

- At Ennis PS, the southern 'rural' pipeline corridor is roughly 5 miles south of the existing PS.

- This route could accommodate deliveries to Lake Bardwell for local use in Ellis County. The southern end of Ennis is land used for future low density residential, while the north end where the corridor could also run through is commercial/industrial. It would essentially parallel 287's run along south Ennis.

- The corridor could also split directly north of Ennis at I-45. From there it would bare west (and just slightly south) to get to the south end of Waxahachie, running across open areas.

- It appears more favorable to run south of Ennis to diversify pump station power supply, proximity to Lake Bardwell and corridor compatibility with current and future land use. It does add some length to the pipe, but that length might be worth the proximity to Bardwell.

- At the south end of Waxahachie (though north of Lake Waxahachie), the line runs west through an area deemed 'mixed use non-residential' and retail in the future land use plan. It actually runs through the border of this land use and the 'highway commercial' land use (same as in the 'urban' corridor). The rest of the area is low density residential/estate.

- The line continues west, essentially avoiding urbanization by staying south of that zone.

- The line runs far south of Midlothian. Though it could be cut closer in to Midlothian, it is likely that it would result in a longer line because of some turns that would be needed to avoid urbanization, or it would result in more urban conflicts.

- Just past the future SH 360 corridor, just east of Venus, the line turns due west and runs north of Venus, snaking through what appears to be very light residential on the west side of FM 2738. The line continues running NW, past the north side of Alvarado and then runs through the north end of Egan. There it meets up with the future Regional Outer Loop - Loop 9 corridor that NCTCOG has in their plans. It is part of the Trans-Texas corridor. It does not have a pending EA/EIS or is not yet under study, but it is a conceptual idea that may get some traction by the time this line is built.

- At FM 1902 (Old Granbury Road), the line turns north and follows this road to the Tarrant/Johnson county border. FM 1902 turns a bit west at that point and our line leaves the road and continues due north to Lake Benbrook.

Table 3-2
Southern "Rural" Corridor Sizing, Flow, Length

Segment	Diameter (inches)	Design Flow (mgd)	Length (mi)
Palestine to Cedar Creek	78	153	38.3
Cedar Creek to Joe Pool Turnout	108	325	62.5
Joe Pool Turnout to Benbrook	84	197	28.3
Interconnection to Joe Pool Vicinity	72	128	7.4
Richland-Chambers to Cedar Creek Interconnection	54	70	12.2
Total	--	--	148.7

3.4 Third Pipeline Corridor

- The Third Pipeline follows the existing ROW from Cedar Creek to Rolling Hills WTP. Between Lake Palestine and Cedar Creek Reservoir, the corridor is the same as the Southern Pipeline. However, this corridor runs into Cedar Creek at the dam; to pump this water through the existing ROW, a new line is required from this location up north to the existing pump station location, or start of the existing ROW. Therefore, a line was built following FM 274. It is possible that the intake at CC would be used only for a southern route, but this alternative assumes the Third Pipeline is being built in the existing ROW and therefore a line is needed from this new intake to the existing ROW per the shortest route (to the existing ROW).

- The Third Pipeline consists of a line from Cedar Creek to the existing Ennis PS, and a line from Richland-Chambers to Ennis PS (a line from Richland-Chambers is needed and is comparable to the Richland-Chamber to Cedar Creek connection in the Southern Pipeline option), then a joint line to Rolling Hills WTP.

- From Rolling Hills WTP, a new line is needed to Lake Benbrook. This line is sized for 150 mgd.

- The line from Rolling Hills WTP to Lake Benbrook is difficult to build because of the heavy urbanization in this area. A tunnel is assumed at this time for the entire length.

Table 3-3
Third Pipeline Corridor Sizing, Flow, Length

Segment	Diameter (inches)	Design Flow (mgd)	Length (mi)
Palestine to Cedar Creek	78	153	38.3
Cedar Creek to Ennis	96	255	32.3
Ennis to Joe Pool Turnout	108	325	32.3
Joe Pool Turnout to RHWTP	84	197	16.3
RHWTP to Benbrook	84	197	9.2
RC to Ennis Alignment	54	70	29.7
Total	--	--	158.2

Table 3-4
Approximate Lengths of Urban and Rural Reaches

Pipe Segment	Rural (mi)	Low Urban (mi)	Medium Urban (mi)	Heavy Urban (mi)	Special Crossings / Tunnel	Total
3PL	75.1	30.7	10.7	1.7	10.5	128.7
SPL (Urban)	94.0	27.4	4.9	--	1.2	127.4
SPL (Rural)	118.7	7.6	1.9	--	1.1	129.3

Note: Lengths represent main transmission line, not interconnections (Richland-Chambers to Cedar Creek, Southern Pipeline to Joe Pool Lake vicinity, Joe Pool Lake vicinity to Bachman WTP)

3.5 Interconnection to Joe Pool Lake Vicinity

- The connection to the Joe Pool Lake vicinity follows the SH 360 corridor, as currently conceptualized by NCTCOG. It ties into the existing transmission lines at the existing blind flange on the TRWD pipeline.

3.6 Connection to Cedar Creek from Richland Chambers

- This line does not follow the existing ROW from Richland Chambers to Ennis PS, even at the beginning, so that the existing ROW remains available for a future pipeline.

- The line does not follow an exact straight line to Cedar Creek Reservoir so that some deciduous forest land near Rush Creek and the Trinity River can be avoided and to accomodate a more direct crossing of the Trinity River.

- This corridor assumes that the delivery point is at the new Cedar Creek intake PS location. This delivery location may move to the west along the Southern Pipeline to avoid a Trinity River crossing, shorten the connection, or perhaps for operational reasons.

3.7 Connection to Dallas Bachman WTP from Joe Pool Lake Vicinity

The preliminary corridor selection between the existing blind flange on the TRWD Richland-Chambers pipeline near Joe Pool Lake and the Dallas Bachman WTP is described in Section 8 of the initial report for this project. The preliminary Bachman corridor selection was not modified in this analysis.

Table 3-5
Interconnection to Bachman WTP: Sizing, Flow, Length

Segment	Diameter (inches)	Design Flow (mgd)	Length (mi)
Joe Pool to Bachman WTP	78	128	27.8

3.8 Energy Delivery Redundancy / Diversification

Reliable electrical power is essential to the operation of the pump stations. There are several methods available to increase reliability of service, including redundant feeders, taking service from a more stable system, and alternative water transmission facilities.

3.8.1 Electrical Distribution Facilities

The electrical distribution system is defined as voltages below 69,000 V. The electric feeders on this system generally originate in a substation and continue one way (radial) to the end. Customers are served from locations all along the line. If there is a failure anywhere along the line, then the entire line is out of service. The pump stations would require a more dependable level of service, which could be accomplished by a second feeder to each station, originating in a different substation and travelling along a completely separate route without sharing any common structures.

3.8.2 Electrical Transmission Facilities

For loads as large as the pump stations on this project, a more stable electrical source is available from the transmission system. The transmission system is a grid, or network configuration. Most lines have a substation or switching equipment at each end, and can therefore be fed from either end. This inherently provides the redundancy of a second feeder from a separate source, as described for distribution lines. If transmission service is taken, then a substation will be needed to convert the transmission level voltage (usually 138,000 V for transmission lines in this area) to the voltage to be used by the pump stations. The substations may be owned and operated by the electric utilities, or by the customer. A utility owned substation might reduce the initial cost and maintenance costs, but the construction schedule would probably be increased, and operational costs (electric bills) would be higher. The ownership of the substations would be negotiated with each electric utility separately, as would the potential for distribution level service with the appropriate redundancy and diversification for reliable service.

3.8.3 Electrical Service Costs

In any electrical service configuration, the electric utility will calculate costs for what is termed "standard facilities." This is the minimum construction required to serve the load. It might include a single distribution line, or several miles of transmission lines. The anticipated billing for the load is used to partially offset the cost of standard facilities. Any additional construction costs incurred by the electric utility would be paid by the customer as a "Contribution In Aid Of Construction" (CIAC) which is a one time, nonrefundable payment to the utility before they begin design or construction of the facilities. Any and all facilities requested by the customer in excess of the standard facilities would also require a CIAC to be paid.

Electric transmission line construction by the electric utility would also require that a "Certificate of Convenience and Necessity" (CCN) be undertaken. This process is very lengthy (up to two years, just to obtain approval to build the line) and as it includes public hearings, the outcome is not guaranteed. Private entities (customers) may construct transmission lines for their own use without going through the CCN process.

3.8.4 Alternative Water Transmission Facilities

The proposed pump stations on the Southern 'Rural' Corridor are located such that electrical transmission service can be obtained from a different portion of the transmission grid than that used by the existing pump stations on the Cedar Creek and Richland-Chambers pipelines at Ennis and Waxahachie. In the unlikely event of a transmission system outage, both pipeline systems (Existing and Southern) would probably not be affected at the same time.

The electric transmission lines in this area of Texas are mostly owned by Oncor Electric Delivery. However, because some of the existing and new Southern Pipeline pump stations are located in areas in which a different company owns exclusive franchise, the final line connections may be by a different utility. This does not create a better or worse situation, but this configuration requires coordination with both Oncor and the alternate utility for electric service. Of the existing pump stations, the Richland-Chambers intake and Ennis are served by Brazos Electric Power Cooperative, which owns transmission lines connected to the Oncor transmission system. Waxahachie and the Cedar Creek intake are directly connected to Oncor. The proposed Southern Pipeline pump stations would be connected to the Oncor system either directly or through Brazos Electric Power Cooperative. Depending on the final selected pump station sites, other utilities that may be involved include Trinity Valley Electric Cooperative and Johnson County Electric Cooperative. The Lake Palestine site is the exception; it would be connected to the Rayburn County Electric Cooperative 69kV transmission system. This system is not included in the ERCOT system but is rather connected to the Southwest Power Pool (SPP) grid.

Section 4
Operations Modeling

4.1 Purpose and Updates

During the initial comparison of strategic alternatives, a system optimization model was developed to identify opportunities to minimize operational and project development costs (See **Figure 4-1**). The model focused on energy costs, as well as on supply reliability, project phasing, and water sharing potential. A description of the model can be found in the previous report entitled *Summary Report: Project Viability Assessment and Business Case Evaluation of Raw Water Transmission System Integration,* dated July 2008.

Following earlier findings that interconnection offers benefits to both supply systems, the model was refined for comparison of the two integrated conveyance alternatives (**Figure 4-1**). It focused on the following four factors associated with routing Lake Palestine through the TRWD system either through a 3rd Pipeline paralleling the existing lines, or through a Southern Pipeline ("SPL") which would follow a more southerly route to connection points near Joe Pool Lake and Lake Benbrook:

- Supply reliability
- Timing of the Lake Palestine need
- Water sharing ("transfer") potential.
- Phasing potential (described in Section 5)

The model was also used to develop input time series for a steady state hydraulics model of the interconnected transmission system, which is discussed in Section 5 of this report. Updates in the optimization model that helped to refine operational understanding of an interconnected system as well as provide clear output for use in the hydraulics model included:

- Improved resolution on the corridor alternatives, supported by the ongoing corridor analysis presented in Section 2
- Improved application of operating rules, including permitted yield constraints (scenarios were analyzed both with and without these constraints)
- Updated demand projections for DWU (Lake Palestine only) and TRWD (specifically, demands on the West Fork and at Rolling Hills).

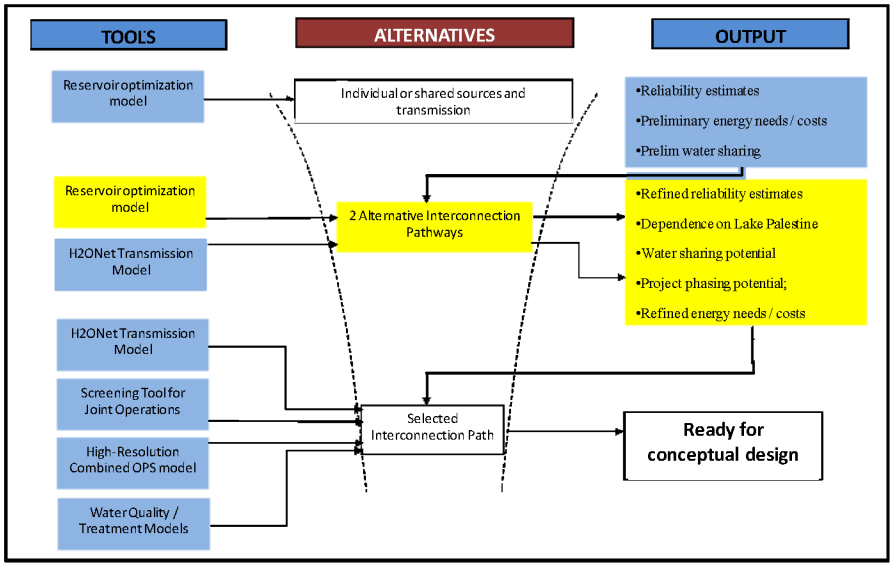

Figure 4-1
Role of the Optimization Model for Comparing 2 Interconnection Alternatives
(Shown in yellow)

Fundamentally, the model was employed to determine if the two routing alternatives for interconnection were substantially different in any of their performance measures, including supply reliability, Lake Palestine timeline, and water sharing potential. The hydraulic model (Section 5) was used to distinguish the two alternatives with respect to energy needs and operating costs.

4.2 Modeling Assumptions

The following assumptions and simplifications were developed to provide a consistent basis of comparison of the two integrated conveyance alternatives, and to yield a model that could distinguish alternatives without the burden of excessive and unnecessary detail.

- The model employs a monthly timestep and results are formulated based on annual averages. For example, a reliable yield during the drought of record is based on the annual flow availability, not potential monthly deficits.

- Firm water needs were defined by simulating the drought of record and existing permitted yield thresholds. A second condition was defined by simulating normal hydrologic conditions and suspending the permitted yield constraints for experimental purposes.

- The system was bounded per **Figure 4-2** to focus on the elements of the systems most directly affected by the new source and conveyance corridors.

- TRWD demand: modeling accounted for all TRWD supplies and demands (customer and terminal storage) but instead of simulating West Fork demands explicitly, they were represented by reducing demand on appropriate nodes within the bounded system in **Figure 4-2**. Hence, West Fork supply and demand is represented implicitly. Demands on the bounded system are summarized in **Table 4-1**.

- Dallas demand: modeling assumed Lake Ray Hubbard yield of 80.1 mgd and linear growth in demand between decadal projections. This results in projected needs for Lake Palestine as follows (also see **Table 4-1**):

  - New supply must be on-line by 2023

  - Full 102 mgd of Lake Palestine by 2042

- Ellis County – full Ellis County demand was accounted for per Region C "Four County Study" (this includes demand which can be partially satisfied with local supplies - Ellis County demand on the interconnected system will therefore be reduced commensurately in future analysis). The "Four County Study" modeling assumptions for TRWD in Ellis County are based on contracted volumes, extending to 2030 and includes supplies from TRWD to meet demand that has not yet been contracted.

- Flow between points connected by more than one pipeline was divided equally between the pipes (on a capacity percentage basis) in order to approximate lowest-cost transmission. For example, deliveries to demand nodes along the Cedar Creek and Richland-Chambers line were divided between the two pipelines such that they carried equal percentages of the respective pipeline capacity.

- No external sources other than Lake Palestine were simulated and hence long-range demand forecasts resulted in simulated water deficits. Deficits in the model were distributed equally by percentage among the following three entities (this assumption will be refined in subsequent work, which will be able to identify location of deficits within each system):

  - DWU

  - TRWD

  - Ellis County (gross demand without consideration of local supplies)

- Demand and permitted yield (including TRWD Wetlands): Analysis was completed with and without the application of permitted yield constraints for the TRWD reservoirs. Permitted yield values (also representing annual safe yield, which would leave water in the reservoirs even during the drought of record) are presented in **Table 4-1**, and results in later sections reflect the significance of these constraints.

- For these sets of analysis, all source water was considered to be available to all users, and the least expensive sources and pathways were tapped first.

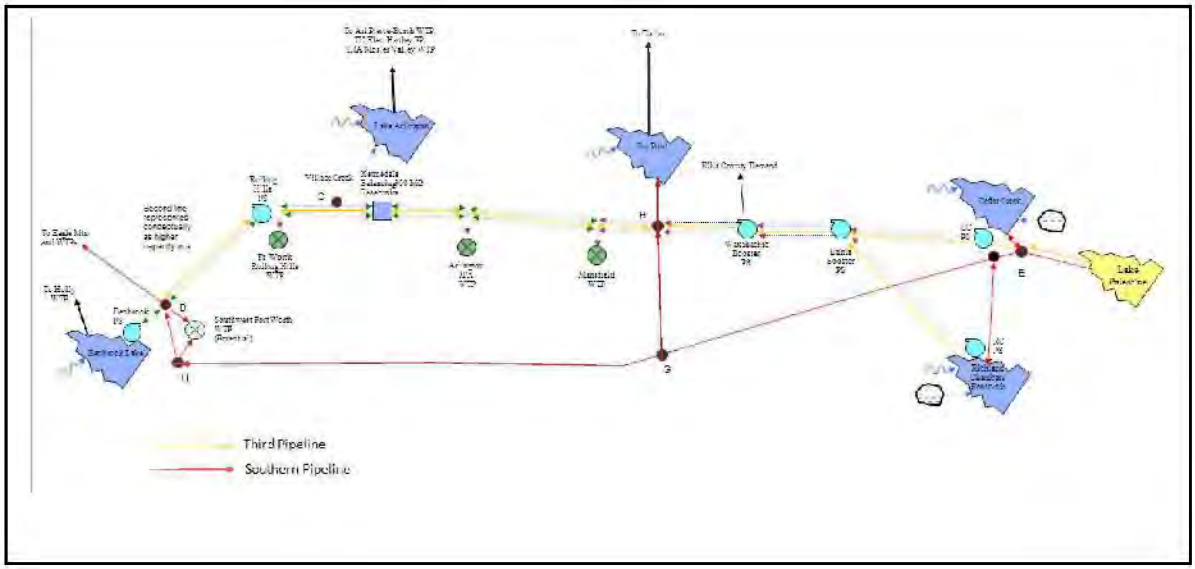

Figure 4-2
Boundaries of Simulated System

Table 4-1
Permitted Supply and Demand Summary

	TRWD and Ellis County							DWU	
	Permitted Yield (mgd)				Average/Max Year Drought Demand (mgd)*			Permitted Yield (mgd)	Avg Drought Demand (mgd)
	RC	CC	Benbrook	Total	TRWD**	Ellis Cty.	Total	Lake Pal	DWU
2020	244	203	65	512	340/401	46	386/447	102	0
2030	244	203	65	512	410/472	60	470/532	102	55
2040	244	203	65	512	466/532	74	540/606	102	102
2050	244	203	65	512	522/592	88	610/680	102	102
2060	244	203	65	512	580/651	104	684/755	102	102

*Average drought demand is computed over the 7-year historical drought of record, while the "Max Year Drought Demand" represents the highest expected annual demand during such a drought.

**TRWD total demand values are reduced by yield from the West Fork, which is not simulated in this analysis, and which is approximately 89 mgd during normal periods, 41 mgd during severe droughts.

4.3 Supply Reliability

The first set of tests conducted with the model were to determine if either of the two integrated conveyance alternatives offered a distinguishable benefit in supply reliability over the other. This was tested both with the application of annual permitted withdrawal constraints from **Table 4-1** along with the drought of record and, experimentally, with the suspension of these annual thresholds (which results in more source water availability) and simulation of normal hydrology.

Figure 4-3 illustrates the results of the analysis. Fundamentally, neither of the two routing alternatives distinguishes itself as superior to the other with respect to supply reliability. Both can satisfy nearly 100% of the total annual system demand through 2030, and both decline to satisfy approximately 70% of total demand by 2060. Clearly, this decline reflects limitations in supply and permitted withdrawals, as scenarios with average hydrologic conditions and suspended permit constraints reveal sufficient water in the system to satisfy nearly all of the demands through 2060.

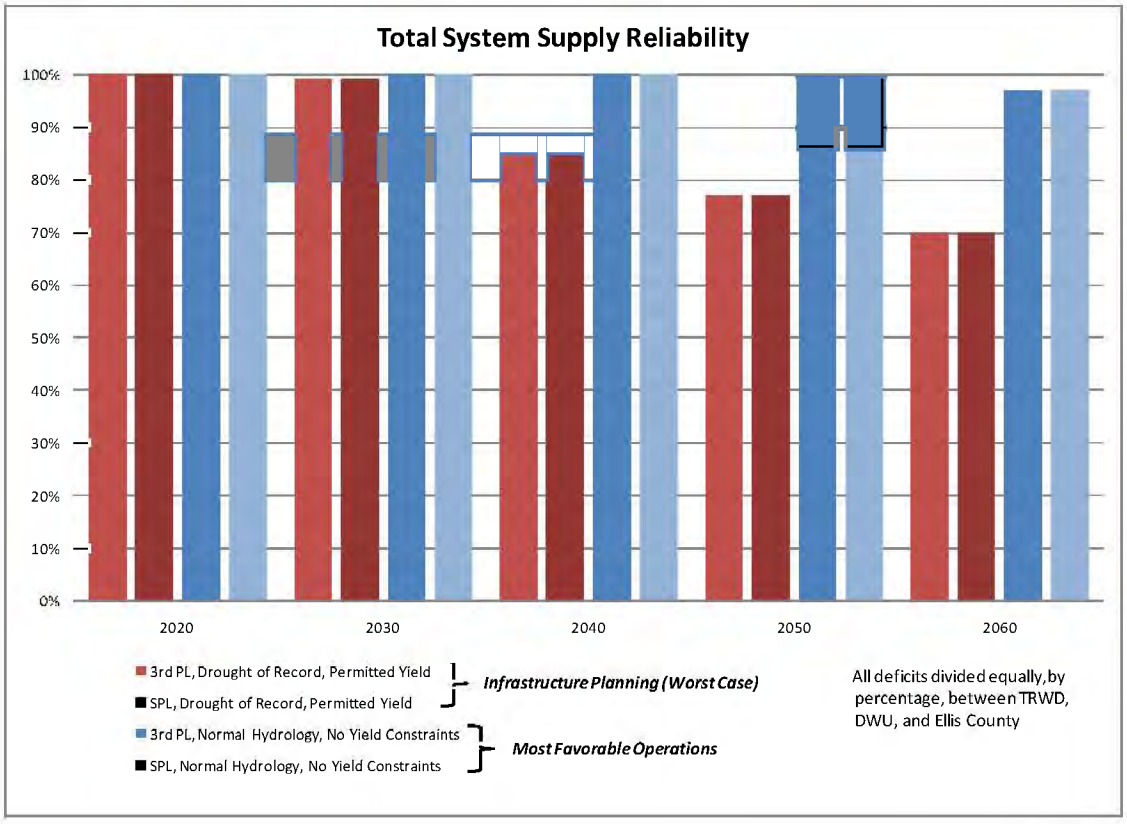

Figure 4-3
System Supply Reliability

4.4 Use of Lake Palestine

In the same way that the model was used to quantify supply reliability with and without the permitted yield constraints, it was helpful in identifying the need for Lake Palestine water in future decades. Firm planning needs were defined with the application of permitted yield constraints and the simulation of the drought of record. "Most favorable" conditions were simulated with normal hydrologic conditions and the suspension of permitted yield constraints (experimentally).

Figure 4-4 illustrates that the firm need for Lake Palestine would begin between 2020 and 2030, but it would not need to produce water at the contract capacity (102 mgd) until approximately 2040. During normal hydrologic periods, and with permitted yield constraints of other TRWD reservoirs experimentally suspended, the existing reservoirs could satisfy projected demand through 2060 without Lake Palestine.

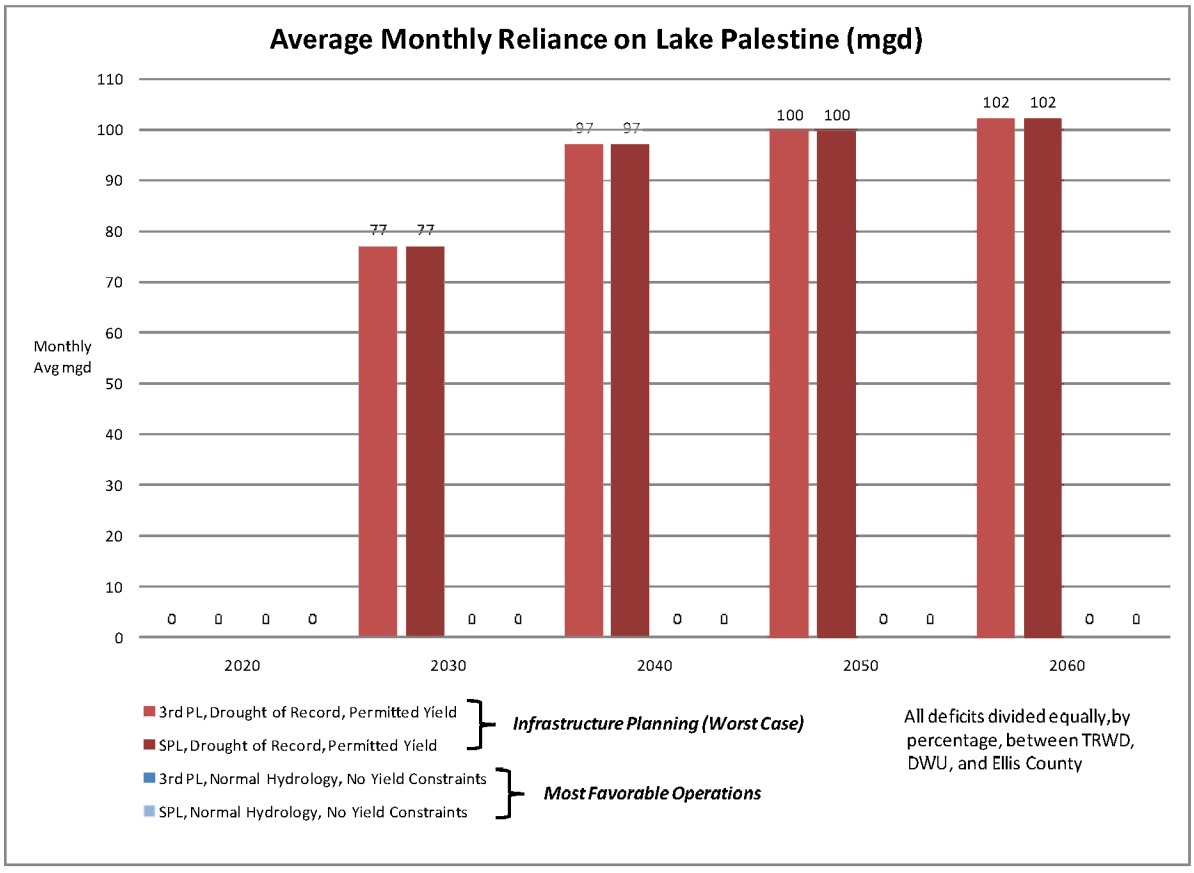

Figure 4-4
Dependence on Lake Palestine Water

4.5 Water Sharing Potential

The potential to share water sources through the integrated conveyance has been assumed to be a consistent opportunity throughout the scenarios presented to this point. The analysis was conducted on the system as a whole, without restricting agency access to specific source water bodies. This section quantifies the potential for water supply sharing between Dallas and TRWD by decade.

Figures 4-5 and 4-6 illustrate the gaps between both system's demands and water availability from their respective sources through 2060. In accordance with the bounded nature of the subsystem most directly affected by Lake Palestine interconnection, Lake Palestine is the only source considered for DWU in this analysis. Effectively, where demand is less than permitted supply, an opportunity exists to provide the volume of water equivalent to the gap to the other system.

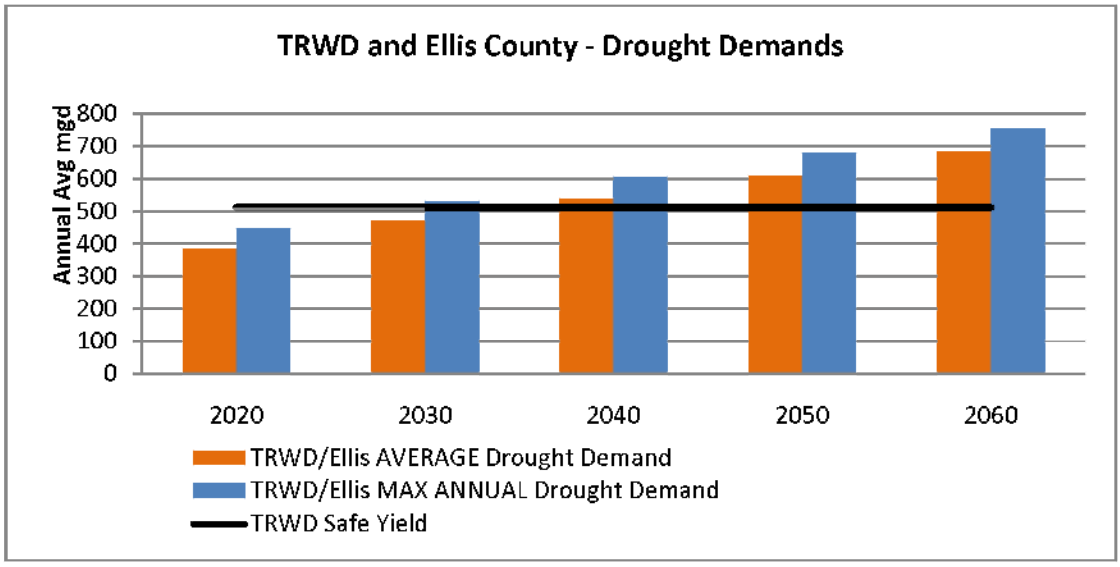

Figure 4-5
Supply vs. Demand for TRWD and Ellis County
Note: Safe Yield includes Richland-Chambers Reservoir, Cedar Creek Reservoir, and Lake Benbrook (and does not include the West Fork reservoirs)

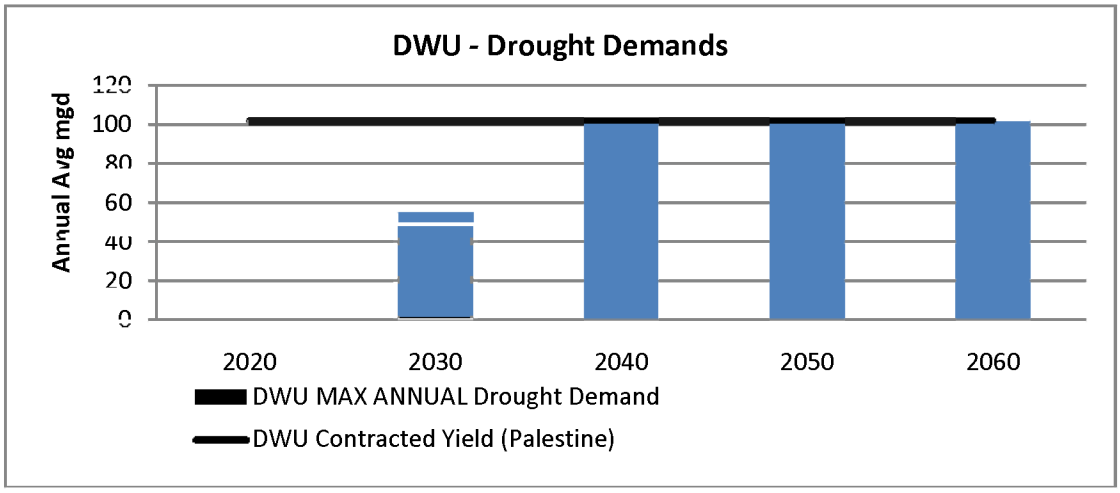

Figure 4-6
Supply vs. Demand for DWU at Lake Palestine

Note: In **Figures 4-5 and 4-6**, "Average drought demand" is computed over the 7-year historical drought of record, while the "Max Annual Drought Demand" represents the highest expected annual demand during such a drought.

Summary of Sharing Opportunities Under Firm Yield Conditions

The following summary focuses on results obtained by simulating the drought of record in conjunction with permitted yield thresholds. **Table 4-2** summarizes opportunities for water sharing between the two systems.

2020: DWU is not expected to need water from Lake Palestine in 2020. However, even during the most extreme drought year, the TRWD system could have 65 mgd that could be made available to DWU. Alternatively, 102 mgd from Lake Palestine could be available to TRWD through 2023, when DWU demand begins to ramp up until in 2040, 0 mgd would be available to TRWD.

2030: DWU may have 47 mgd available from Lake Palestine, while TRWD could face a deficit of 20 mgd during the most extreme drought year. Hence, DWU could provide 47 mgd on a reliable basis to TRWD. However, TRWD supply planning anticipates development of additional supplies prior to 2030.

2040 – 2060: From 2040 onward, both systems project demand that eliminates water sharing potential under firm yield conditions. See below, however, for opportunities under normal hydrologic conditions.

Summary of Opportunities to Share Water under Normal Hydrologic Conditions

Analysis to this point has been based on deliveries and demands projected on normal hydrologic conditions and the historical 7-year drought of record. Under normal hydrologic conditions, there are greater opportunities for water sharing, though they should be viewed only as operational opportunities, not firm commitments.

Table 4-2 summarizes opportunities for water sharing between the two systems. The summary includes opportunities during normal hydrologic periods, as well as firm commitments that could be made based on the historical drought of record.

Table 4-2
Water Transfer Potential

All flows in mgd	2020*		2030*		2040*		2050*		2060*	
	TRWD to DWU	DWU to TRWD	TRWD to DWU	DWU to TRWD	TRWD to DWU	DWU to TRWD	TRWD to DWU	DWU to TRWD	TRWD to DWU	DWU to TRWD
Available with normal hydrology**	102+	102	102	102	102	102	102	102	102	102
Avg. Avail during Drought of Record	126	102	42	47	0	0	0	0	0	0
Available during worst drought year	65	102	0	47	0	0	0	0	0	0

*Columns are either/or for any given month

Normal hydrology scenarios also are **not constrained by permitted yield. Values are capped at 102 even though more may be available from TRWD to DWU.

4.6 Conclusions from Operations Modeling

The operations model was intended to identify upper bounds on the opportunities to realize benefits of system interconnection, and also to help identify any substantial performance differences between the two integrated conveyance alternatives (with the exception of costs, which were covered with separate analyses). The following conclusions can be drawn from this analysis:

- There are no significant performance differences between the two integrated conveyance alternatives (reliability, dependence on Lake Palestine, and water sharing potential).
- Reliability:
  - Both provide ~100% firm reliability (on an annual average basis) up to 2030 (under all hydrologic conditions)
  - Beyond 2030, firm reliability < 100% (source water supply in addition to the confined system would be needed to satisfy demand fully)
- Lake Palestine Needs (Firm planning basis):
  - No demand on Lake Palestine before 2020
  - Partial capacity needed by 2030 (~75 mgd)
  - Full capacity needed by 2040 (102 mgd)
- Firm Water Sharing Potential
  - 2020: up to 65 mgd to DWU or up to 102 mgd to TRWD
  - 2030: up to 47 mgd to TRWD
  - 2040 – 2060: No reliable sharing potential without additional supply sources

Section 5
Pipeline Phasing Opportunities

5.1 Goals of Phasing Study

The purpose of this analysis was to identify opportunities to defer the construction of portions of the integrated conveyance alternatives to potentially spread associated capital costs over time. Results were obtained by removing sections of pipeline from the operations model described in Section 4, and then simulating drought conditions. These results therefore identify opportunities for phasing based on water supply reliability under a specific set of assumed conditions (drought of record in the 1950's, connection of TRWD constructed wetlands, etc.) and do not consider other factors that weigh in the decision to defer construction of pieces of the conveyance system.

While there may also be opportunities to construct or expand pump stations incrementally over time, this analysis focused mainly on the pipeline reaches, assuming that the opportunities for cost savings would be more substantial with respect to the pipeline. Certainly, additional opportunities exist, but this analysis was conducted at a macro-scale for the sake of differentiating the conveyance alternatives.

Two operating conditions were used in this comparison; full reliability and the acceptance of a small reliability risk. Both are discussed below. Phasing scenarios are compared against a baseline construction scenario which produces a complete pipeline by 2018.

5.2 Phasing for Full Reliability

The system was first evaluated to examine phasing strategies that would not reduce the firm supply reliability estimates presented in Section 3. Since it is estimated that Lake Palestine water supply would not be needed by the City of Dallas on a firm basis until 2023, both integrated conveyance alternatives could defer the connection of Lake Palestine to Cedar Creek Reservoir until then, thereby spreading approximately $200M over a slightly longer period than would be required if the full pipeline from Lake Palestine to western Tarrant County were completed by 2015.

The 3rd Pipeline offers one additional opportunity for phased implementation, which is the connection between the Rolling Hills WTP and Lake Benbrook. This connection could conceivably be deferred until 2030, thereby deferring approximately $300M an additional 15 years.

As currently envisioned, the Southern Pipeline does not offer the flexibility to defer the connection to Benbrook. Deferring completion until 2030 could create potential for water shortages at Mansfield WTP, Arlington WTP, Lake Arlington, and Rolling Hills WTP. The Southern Pipeline delivers less water to the DWU takeoff (represented as Joe Pool Lake in this analysis, but will more likely lead to the Bachman WTP) than does the 3rd Pipeline under future peak conditions. Without the connection between Rolling Hills WTP and Lake Benbrook, the 3rd Pipeline could still

supply needed water to these demand nodes, while it is unlikely that demand could be fully supplied with the Southern Pipeline. The 3rd Pipeline would deliver 325 mgd to the Joe Pool takeoff point, leaving almost 200 mgd *and conveyance capacity* for TRWD demand nodes downstream to Rolling Hills after DWU withdrawals. The Southern Pipeline would deliver only 128 mgd to the Joe Pool takeoff point, leaving no additional water or conveyance capacity to the demand nodes from Mansfield WTP to Rolling Hills WTP (See **Figure 5-1**). While approximately 200 mgd conveyance capacity would be available to backflow from Benbrook to Rolling Hills via the Southern Pipeline, this capacity would be of little use on a firm basis if the Southern Pipeline was not completed all the way to Benbrook to close the backflow loop.

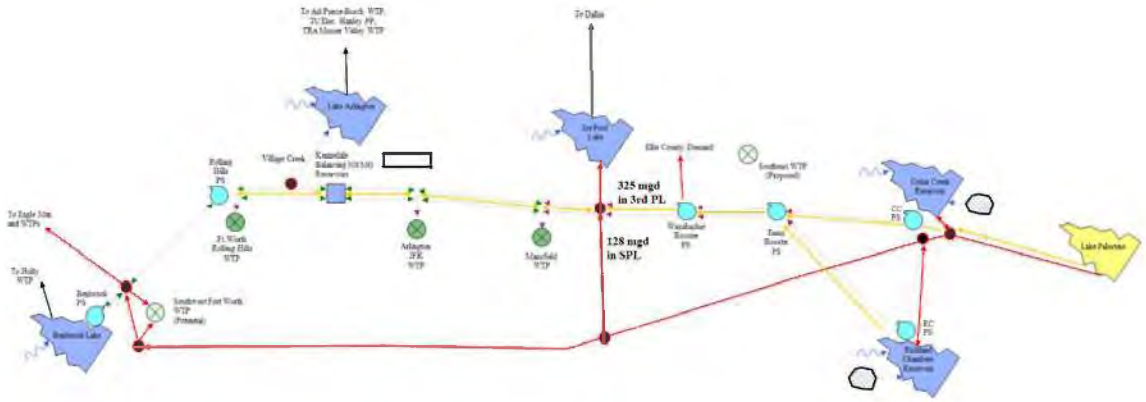

Figure 5-1
Impacts of Deferring Additional Connection between Rolling Hills and Benbrook

5.3 Phasing with Small Supply Risk

The above analysis suggests phasing opportunities that would not reduce the ability of the system to provide the supply reliability performance estimated in Section 3. However, with the acceptance of a small risk, additional phasing opportunities could be considered. Additional external supplies will reduce or eliminate the risk of water deficits.

The following alternatives could be considered, and are summarized in **Figure 5-2**:

- Third Pipeline
  - Defer Palestine to Cedar Creek connection (approx. $200M) to completion by 2023
  - Defer Joe Pool (Bachman takeoff) to Lake Benbrook connection (approx. $350M)
    - Connect to Kennedale by approximately 2025

- Connect to Benbrook by approximately 2035

- Southern Pipeline
  - Defer Palestine to Cedar Creek connection (approx. $200M) to completion by 2023
  - Defer Joe Pool (Bachman takeoff) to Lake Benbrook connection (approx. $300M) to completion by 2025

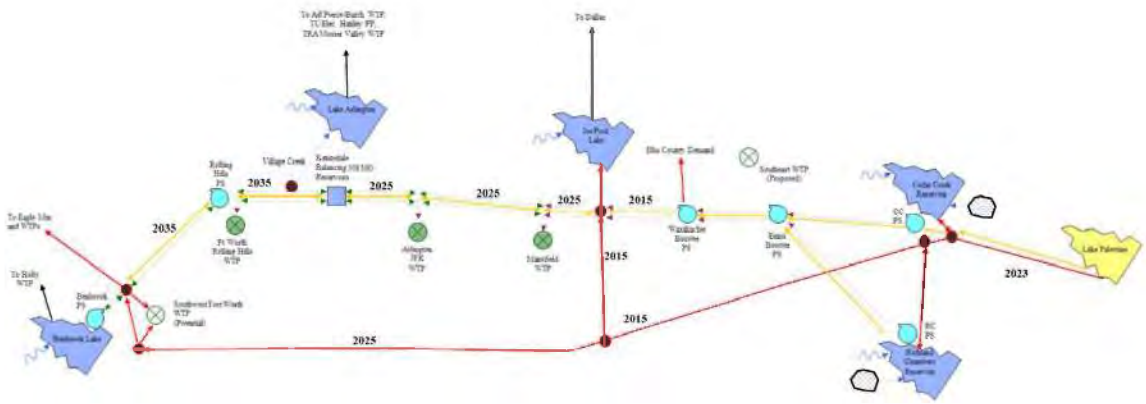

Figure 5-2
Potential Timing of Pipeline Segments with Small Reliability Risk

5.4 Phasing Conclusions

Figure 5-3 summarizes the analysis of phasing potential for the two integrated conveyance alternatives. Generally, the 3rd Pipeline offers greater flexibility with phasing opportunities because, as currently sized, it would deliver substantially more water to a Dallas delivery point, and would offer greater downstream conveyance to four TRWD demand nodes even without going initially to Benbrook. That is, after DWU takes its allocated water from the system, the 3rd Pipeline would still be able to supply and convey 200 mgd (approximately) to TRWD demand nodes.

Opportunities for phasing in the Southern Pipeline alternative are more limited because there is not adequate capacity in the existing East Texas pipelines to deliver additional water from the location of the blind flange at Joe Pool Lake (where the Southern Pipeline would deliver additional water to the existing pipelines) to TRWD demand nodes farther west.

All of these scenarios were evaluated conceptually, and more detailed daily operating scenarios continue to be evaluated in the TRWD-Dallas RiverWare model.

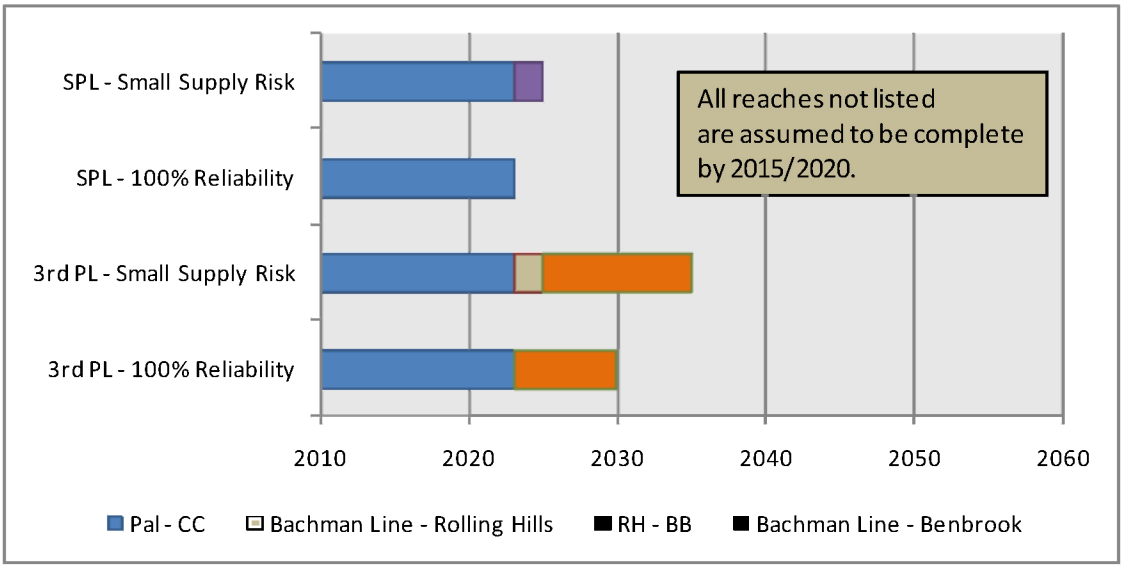

Figure 5-3
Potential Phasing Summary (Firm Supply Reliability Analysis)

Section 6
Hydraulic Modeling

6.1 Introduction and Approach

The purpose of this section is to describe the hydraulic modeling effort as defined in Task 1.4 of Phase I, Amendment 2 of the Raw Water Transmission System Integration Study. The primary objectives of this analysis are to support development of a recommended conveyance alternative by:

1. Refining the energy usage assessment and developing updated operational costs estimates for the Southern and Third Pipeline interconnected conveyance alternatives; and

2. Calculating preliminary infrastructure sizes (pipe diameter and pump station horsepower).

Hydraulic modeling of the Southern and Third Pipeline alternatives includes the system as bounded by Figure 4-2 in Section 4 of this report. Existing transmission lines were included to examine alternative flow-splitting strategies. The purpose of the model was to determine operational cost estimates using a long-term simulation of flow transmission; day-to-day operations of the integrated conveyance system are not formulated.

The hydraulic modeling software used in this study is MWH Soft's H2ONET, an interactive water distribution system modeling tool that runs within AutoCAD. H2ONET is in essence a pre- and post-processor for the EPANET engine. TRWD provided CDM with two existing hydraulic models, one developed in H2ONET and the second in EPANET. Though the EPANET model has a current representation of existing TRWD system hydraulics, the model does not include portions of the transmission network that are required for this analysis; those missing system pieces were included in the H2ONET model. However, the H2ONET model was not representative of the most current system hydraulics. Using TRWD's recommendation, modeling for this phase of the project is carried out using the existing H2ONET model with updates to the system hydraulics incorporated based on the EPANET model.

A hydraulic model was created for the two primary interconnected conveyance alternatives – the Southern Pipeline and the Third Pipeline (see Figure 1-3). Because the purpose of this analysis is to compare these two primary corridors, only one of the two Southern Pipeline alternatives is modeled here. The Southern "Rural" Pipeline corridor is selected for hydraulic analysis because it represents a larger contrast to the Third Pipeline from a hydraulics perspective.

Fundamental components of the modeling approach are summarized below:

- Average annual energy cost estimates are derived through simulation of monthly flows over a 7-year period of average hydrologic conditions;
- Monthly demands and reservoir operations are based on results from the Operations Model (as described in Section 4);
- Model flows are driven by demand nodes (WTP's);
- Pump station horsepower and system energy usage are calculated from the total dynamic head in each conveyance segment over the course of a 7-year simulation.

6.2 Assumptions and Criteria

Data used in the hydraulic model was obtained from the existing H2ONET and EPANET models and from TRWD and DWU (updated pump curves, pipeline capacity, and other data regarding operational principles of the existing transmission system). Section 2 of this report details criteria and standards used in this project; below is a list of criteria specific to the hydraulic model.

- Proposed pipes are sized based on peak design flow velocity of 8 feet per second (peak to average flow factor of 1.25) and maximum working pressure of 200 psi.
- Existing pipe capacities and pressures are defined by TRWD for existing pipelines (see Table 2-2 in Section 2 of this report):
  - Cedar Creek Line: Cedar Creek Reservoir to Ennis booster pump station (BPS)
  - Richland-Chambers Line: (Richland-Chambers Reservoir to Ennis BPS)
  - Parallel Lines: (Ennis BPS to Kennedale Balancing Reservoir)
  - Kennedale to Rolling Hills Water Treatment Plant (WTP)
  - Rolling Hills WTP to Lake Benbrook
- The H2ONET model is run using the Darcy-Weisbach friction factor option.
- Electricity is assumed to be supplied from the existing transmission system and therefore all pumps are assumed to be configured with Variable Speed Drives (either presently or upgradable).
- A firm yield criterion is applied to reservoir operations in the hydraulic model. Reservoir yields (permitted annual and peak values) used in the hydraulic model are shown in **Table 6-1** (more detail provided in Table 2-2 in Section 2 of this report). Permitted yield values are assigned as reservoir supplies to the model and peak values are used to size the transmission system.

Table 6-1
Reservoir Yields used in the Hydraulic Model

	Lake Permit (Average Annual) (ac-ft/yr)	Wetlands (Average Annual) (ac-ft/yr)	Total Average Annual (ac-ft/yr)	Total Peak* (ac-ft/yr)	Total Peak (1.25 factor) (MGD)
Cedar Creek Reservoir	175,000	52,500	227,500	284,375	254
Richland-Chambers Reservoir	210,000	63,000	273,000	341,250	304
Lake Palestine	114,337	n/a	114,337	224,200	153 to CC, 128 beyond

- **Table 6-2** contains data on the existing TRWD transmission system capacity from Cedar Creek and Richland-Chambers Reservoirs to the west, and the calculated additional capacity needed to convey "new water" from the constructed wetlands and Lake Palestine.

Table 6-2
Peak Capacities used in Hydraulic Model

	Existing System Peak Capacity @ 8fps (MGD)	Proposed Peak† Capacity (CC/RC/Constructed Wetlands Yield + Palestine) (MGD)	Additional Peak† Capacity Needed to Convey "New Water" (MGD)
Palestine to Cedar Creek	n/a	153	153
Cedar Creek Line (CC to Ennis)	127*	382 (128 Pal + 254 CC)	255
Richland Chambers Line (RC to Ennis)	246	316	76
Combined (Ennis to Kennedale)	373	698 (382 + 316)	325
Kennedale to RH WTP	127 + 228 = 355, 225 reverse flow		
RH WTP to Benbrook	110 Gravity, 200 with RHBPS, 225 reverse flow		

**Note: At 8 fps capacity is 146 MGD. Actual system constraints limit this value to 127 MGD.*

***Note: Used 244 in Phase 1 Ops Model*

†Note: 1.25 peaking factor

- Existing pump capacities are shown in **Table 6-3**. The difference between values in Table 6-3 and Table 6-2 represents the additional pumping capacity needed.

Table 6-3
Existing Pump Capacities

Pipeline/Segment	Design Pumping Rate	Maximum Allowable Pumping Rate	Comments
Cedar Creek			
Lake to Waxahachie	70 mgd	68 mgd	Minor limitation
Lake to Ennis	134 mgd	129 mgd	Limited by allowable pipe pressure rating in low lying area west of Lake PS
Ennis to Waxahachie	134 mgd	127 mgd	Limited by allowable pipe pressure rating in the eastern half of this line segment
Waxahachie to Balancing Reservoir	134 mgd	129 mgd	Major limiting sections replaced
Richland Chambers			
Lake to Waxahachie	148 mgd	141 mgd	Minor limitation
Lake to Ennis	249 mgd (2020)	247 mgd	Minor limitation
Ennis to Waxahachie	249 mgd (2020)	246 mgd	Minor limitation
Wax to Bal Reservoir	249 mgd (2020)	247 mgd	Pipe pressure limitation west of Mansfield Tap will be corrected before 2010

- Friction factors used in each pipeline in the hydraulic model are listed in **Table 6-4**. Pipe material in the proposed pipelines will likely vary between steel in urban settings and PCCP in rural settings. In this hydraulic analysis, the friction factor is assumed to be equivalent for both pipe materials.

Table 6-4
Friction Factors of Existing and Proposed Pipelines in the Hydraulic Model

Pipeline	Pipe Condition	Friction Factor	Absolute Roughness (feet)
Cedar Creek			
Existing 72-inch	Existing, Deteriorated	0.019	0.005
Relined	Reconditioned	0.014	0.001
Proposed 90-inch	Mid Term	0.012	0.0005
Richland-Chambers			
Existing 90-inch	Existing	0.016	0.003
Proposed 60-inch	Mid Term	0.012	0.0005
Third/Southern Pipeline (108-inch)	Mid Term	0.011	0.0004

- Hydraulic modeling was performed for a 7-year period of average hydrologic conditions.
- Proposed pump curves used in the hydraulic model (for additional pumps in existing pump stations and pumps in new pump stations) are based on existing pump curves. The following curves are used to represent each pumping station:
  - Cedar Creek Intake Pump Station Curve
    - Palestine Intake PS
    - Existing Cedar Creek Intake PS
    - Proposed Cedar Creek Intake/BPS
    - Rolling Hills Booster PS
  - Richland-Chambers Pump Curve: Richland-Chambers Intake PS
  - Ennis BPS: Ennis Pump Station
  - Waxahachie BPS: Waxahachie Pump Station
  - Southern Pipeline BPS's: used existing Waxahachie BPS curves
- For the Phase I, Amendment 2 hydraulic analysis, some simplification of existing system operations are incorporated to support long-term simulations (to be refined in future phases of design).

- Kennedale Balancing Reservoir: operation of the balancing reservoir (250 to 300 MG of storage) is not included in the hydraulic model, but the facility elevation is included to account for impacts on head loss and total dynamic head.

- Low/High Capacity Operations: TRWD currently operates pumps from Cedar Creek and Richland-Chambers Reservoirs to the Waxahachie Booster Pump Station (BPS) in two modes. Under low flow conditions (less than 150 MGD in Richland-Chambers line and 76 MGD in Cedar Creek line) the Ennis BPS is not needed; above this threshold Ennis BPS is utilized. The hydraulic model currently does not differentiate between high and low capacities and uses both Ennis BPS and Waxahachie BPS to generate the required dynamic head. Because tariff structures are not applied in the hydraulic model, this does not change the cost of energy usage; this analysis calculates gross energy usage.

- Longitudinal ground profiles used to represent the interconnected Third Pipeline and Southern Pipeline alternatives are shown in **Figure 6-1**.

6.3 Results

This section explains results for the hydraulic modeling analyses: transmission system infrastructure sizing and energy usage estimates. All model simulation runs are performed using a daily time-step and using output from the operations model (see Section 4) runs for each decade from 2020-2060; reservoir yield values used in the operations model are assigned to the hydraulic model. Flow apportionment logic (between pipelines) developed in the operations model is used to drive the pump station control logic in the hydraulic model. Flows delivered at each demand node in the operations model are assigned to demand nodes in the hydraulic model.

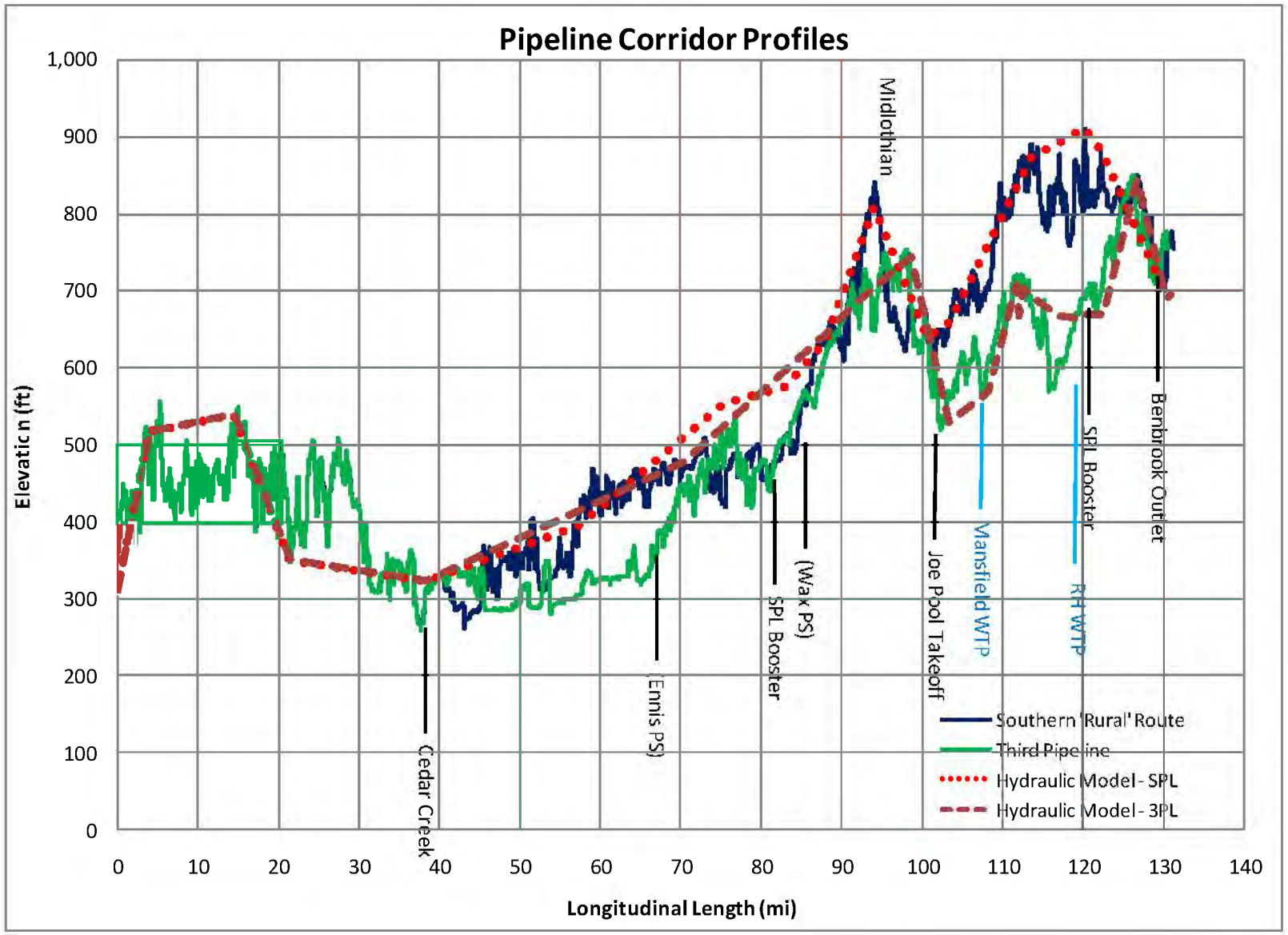

Figure 6-1
Pipeline Corridor Profiles used in Hydraulic Model

6.3.1 Transmission System Sizing

A simulation for each segment is used to calculate preliminary sizes of transmission system infrastructure. Each segment is assigned a demand that could be conveyed while satisfying a velocity requirement of 8 feet per second and a pressure rating of 200 psi. Pump types and pumping capacities of the proposed transmission system are determined by subjecting each pump station to the peak capacity requirement for pipelines associated with the pump station. Total dynamic head results from the hydraulic model are then used to determine locations of proposed pump stations. Proposed pump curves are assumed to be similar to existing pumps at the same location.

A detailed description of transmission system sizes is provided in Appendix A and summarized below in **Table 6-7**. A comparison of existing, Interconnected Third Pipeline, and Interconnected Southern Pipeline system pumping capacity (in terms of horsepower) is presented in **Table 6-8**. Comparing the pumping capacities of the existing and proposed systems, it can be concluded that the pumping capacities required by the proposed system are approximately twice the amount provided in the existing system and horsepower requirements of the Third Pipeline and the Southern Pipeline alternatives are similar (2.5% difference).

Table 6-7
Preliminary Infrastructure Sizing

Alternative	Segment	Diameter (inches)	Design Flow (mgd)	Length (mi)
Southern Corridor-Rural Alignment	Palestine to Cedar Creek	78	153	38.3
	Cedar Creek to Joe Pool Turnout	108	325	62.5
	Joe Pool Turnout to Benbrook	84	197	28.3
	Southern Corridor (Rural Alignment) - Turnout on SPL to Joe Pool	72	128	7.4
	Southern Corridor- RC to CC Alignment	54	70	12.2
Southern Corridor-Urban Alignment	Palestine to Cedar Creek	78	153	38.3
	Cedar Creek to Joe Pool Turnout	108	325	64.4
	Joe Pool Turnout to Benbrook	84	197	24.5
	Southern Corridor (Urban Alignment) - Turnout on SPL to Joe Pool	72	128	1.6
	Southern Corridor- RC to CC Alignment	54	70	12.2
Third Pipeline	Palestine to Cedar Creek	78	153	38.3
	Cedar Creek to Ennis	96	255	32.3
	Ennis to Joe Pool Turnout	108	325	32.3
	Joe Pool Turnout to RHWTP	84	197	16.3
	RHWTP to Benbrook	84	197	9.2
	RC to Ennis Alignment	54	70	29.7
Connections	Joe Pool to Bachman WTP	78	128	27.8

Table 6-8
Comparison of System Pumping Capacity

Modeled System Existing Pumping Capacity		Modeled System Pumping Capacity – Third Pipeline Alternative		Modeled System Pumping Capacity – Southern Pipeline Alternative	
Segment	Total HP	Segment	Total HP	Segment	Total HP
CC Intake	18,000	CC Intake	45,000	CC Intake	45,000
RC Intake	16,500	RC Intake	49,500	RC Intake	49,500
Ennis - CC Line	15,000	Ennis - CC Line	15,000	Ennis - CC Line	15,000
Wax - CC Line	15,000	Wax - CC Line	15,000	Wax - CC Line	15,000
Ennis - RC Line	25,000	Ennis - RC Line	55,000	Ennis - RC Line	25,000
Wax - RC Line	25,000	Wax - RC Line	55,000	Wax - RC Line	25,000
Rolling Hills PS	18,000	Rolling Hills PS	24,000	SPL PS (near Wax)	30,000
Total (Existing)	**132,500**	Palestine Intake	18,000	SPL PS (near BB)	25,000
		Total (proposed)	**258,500**	Rolling Hills PS	18,000
				Palestine Intake	18,000
				Total(proposed)	**265,500**

6.3.2 Energy Usage

Twelve model simulations are completed for the interconnected system: six runs correspond to the Interconnected Third Pipeline alternative and six correspond to the Interconnected Southern Pipeline alternative. Simulations are based on supply/demand data for a seven-year period representing each of the decades 2020, 2030, 2040, 2050, and 2060 respectively. Demand data used in the hydraulic model runs are listed in Appendix B. Flow and total dynamic head results for each of the six decadal runs are exported for post-processing of cost calculations.

Horsepower is calculated using a wire to water efficiency of 65%, which is slightly less than the value of 67.5% used in the previous phase of work (90% Motor Efficiency and 75% Pump Efficiency). An average value of 8 cents per KWh is used to determine the energy costs.

Table 6-9 presents the details of average flows delivered and operational costs in each decade. Results presented in this table are used to compare energy costs incurred for the Third Pipeline and Southern Pipeline as part of the preferred alternative selection process.

Table 6-9
Comparison of Hydraulic Model Simulation of Third Pipeline and Southern Pipeline Alternatives

	3rd PL - HYD Model				SPL - HYD Model			
Year	Delivered Avg (MGD)	$M/Yr	$M/mgd	$/kgal	Delivered Avg (MGD)	$M/Yr	$M/mgd	$/kgal
2020	299	$23	0.08	$0.21	298	$24	0.08	$0.22
2030	429	$36	0.08	$0.23	425	$37	0.09	$0.24
2040	538	$51	0.09	$0.26	526	$49	0.09	$0.26
2050	593	$57	0.10	$0.26	571	$56	0.10	$0.27
2060	642	$65	0.10	$0.28	604	$62	0.10	$0.28

A detailed review of model results for the Third Pipeline and Southern Pipeline alternatives leads to the conclusion that the difference in energy usage/cost between the two alternatives is not significant enough at this level of detail to select between the alternatives based solely on this criterion, and that any difference would only be apparent with more detailed and extensive modeling of both alternatives to replicate existing system operations, and analyze proposed system hydraulics. It does suggest lower overall operational costs compared to analysis completed in the previous project phase. **Table 6-10** summarizes the total cost for the individual alternatives and the average of the cost obtained for the two alternatives. The plot shown in **Figure 6-2** represents the trends in the average annual operational costs over the modeling period.

Table 6-10
Average Annual Energy Cost based on Hydraulic Modeling

Decade	3rd PL - HYD Model	SPL - HYD Model	Average
	$ M/Yr	$ M/Yr	$ M/Yr
2020	$23	$24	$24
2030	$36	$37	$37
2040	$51	$49	$51
2050	$57	$56	$58
2060	$65	$62	$66

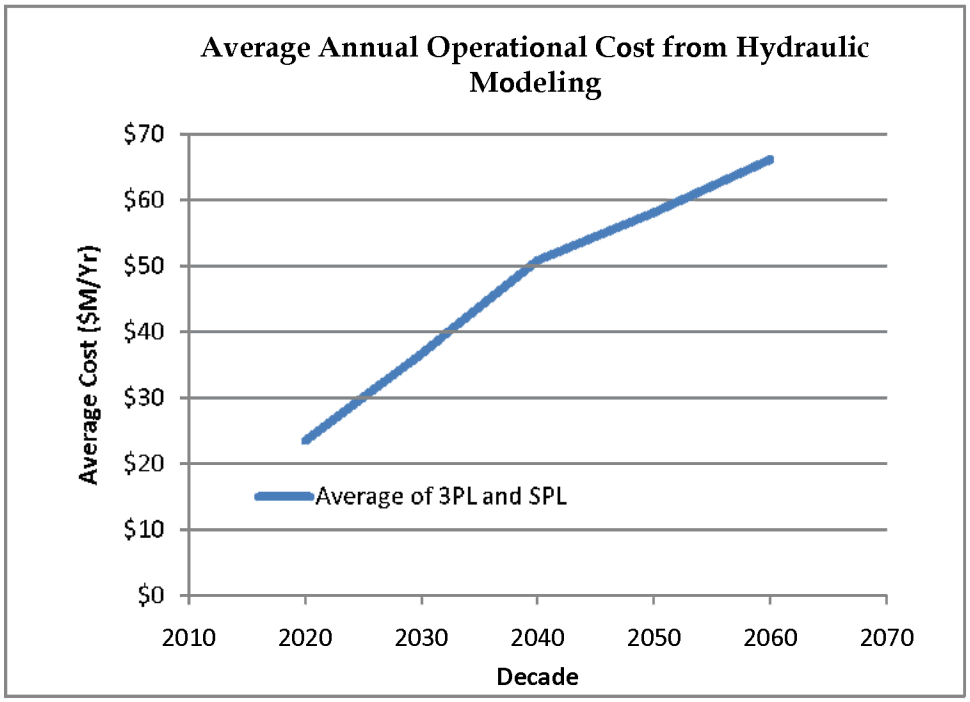

Figure 6-2
Average Annual Operational Costs from Hydraulic Modeling

Section 7
Cost Analysis

This section describes the project cost analysis history and the current basis for the feasibility/conceptual level opinion of probable capital cost and life cycle cost.

7.1 Phase 1 Cost Analysis Results

These results were documented previously and are repeated here to present a complete picture in this document of the cost analysis history. Below is a list of alternatives analyzed in Phase 1:

Alternative	Description
1 (Baseline)	Independent Systems: TRWD's East Texas Third Pipeline and DWU's connection of Lake Palestine to the proposed Southeast Water Treatment Plant
2 (Baseline)	Independent Systems: TRWD's East Texas Third Pipeline and DWU's connection of Lake Palestine to Joe Pool Lake
3 (Interconnection)	Integrated System: Interconnected Third Pipeline (upsized as compared to the baseline condition) with connection of Lake Palestine to Cedar Creek Reservoir and delivery to DWU at Joe Pool Lake and TRWD's customers through the Third Pipeline
4 (Interconnection)	Integrated System: Interconnected "Southern Pipeline" - Lake Palestine delivered to the Lake Benbrook pipeline via a pipeline route to the south of the TRWD Third Pipeline route. Delivery to DWU at Joe Pool Lake and TRWD's customers through connections to the existing system and the Lake Benbrook pipeline.

Results of Phase 1 capital cost analysis:

Baseline Alternatives	Capital Cost (2008 basis)
Alternative 1: TRWD Third Pipeline + DWU Lake Palestine to SE WTP	$1,177,844,000
(Component 1: DWU Lake Palestine to SE WTP)	(548,949,000)
(Component 2: TRWD Third Pipeline)	(628,894,000)
Alternative 2: TRWD Third Pipeline + Lake Palestine to Joe Pool Lake	$1,303,360,000
(Component 1: DWU Lake Palestine to Joe Pool Lake)	(674,466,000)
(Component 2: TRWD Third Pipeline)	(628,894,000)
Interconnection Alternatives	
Alternative 3: Interconnected Third Pipeline	$1,083,966,000
Alternative 4: Interconnected Southern Pipeline	$1,355,279,000

Results of Phase 1 life cycle cost analysis:

Baseline Alternatives	Total Cost (50-year Life)	Present Value Cost
Alternative 1: TRWD Third Pipeline + DWU Lake Palestine to SE WTP	$6,043,044,000	$2,462,651,000
(Component 1: DWU Lake Palestine to SE WTP)	(2,738,178,000)	(1,198,104,000)
(Component 2: TRWD Third Pipeline)	(3,304,866,000)	(1,264,547,000)
Alternative 2: TRWD Third Pipeline + Lake Palestine to Joe Pool Lake	6,774,762,000	$2,776,834,000
(Component 1: DWU Lake Palestine to Joe Pool Lake)	(3,469,896,000)	(1,512,287,000)
(Component 2: TRWD Third Pipeline)	(3,304,866,000)	(1,264,547,000)
Interconnection Alternatives		
Alternative 3: Interconnected Third Pipeline	5,578,924,000	2,238,879,000
Alternative 4: Interconnected Southern Pipeline	6,306,874,000	2,740,189,000

Comparisons between Phase 1 baseline alternative and interconnected alternative results:

Interconnection Alternative	Comparison Baseline Alternative	Total Cost Difference	Present Value Cost Difference
3 (Interconnected Third Pipeline)	1 (w/ Pal. to SE WTP)	$464,120,000	$223,771,000
3 (Interconnected Third Pipeline)	2 (w/ Pal. to Joe Pool)	1,195,837,000	537,954,000
4 (Interconnected Southern Pipeline)	1 (w/ Pal. to SE WTP)	$-263,830,000	$-277,538,000
4 (Interconnected Southern Pipeline)	2 (w/ Pal. to Joe Pool)	467,887,000	36,644,000

7.2 Phase 1 Amendment 1 Cost Analysis Results

These results were documented previously and are repeated here to present a complete picture in this document of the cost analysis history. The purpose of Amendment 1 was to consider additional cost and treatment implications for transmission of raw water to DWU treatment and distribution system facilities from project conveyance Alternatives 1 and 3, which respectively represent the independent and interconnected raw water transmission system. These additional

treatment and water transmission facilities that may be required for a fully functional integrated strategy for DWU were beyond the initial study boundary; therefore, costs implications in this section are additive to the DWU project conveyance alternative costs. These costs do not include distribution system improvements needed downstream of the water treatment plants.

Results	DWU Scenario		
	1 Bachman WTP	2 Southeast WTP	3 WTP at Joe Pool
Conveyance Capital Cost[1]	$171,132,000	n/a	n/a
Treatment Infrastructure Capital Cost	No Cost at Bachman WTP + Elm Fork Expansion (~$200,000,000)	$215,000,000	$204,000,000
Treatment Op. Cost (per MGal Treated)	$60	$66	$60
Present Value of 50-year Life-Cycle Cost	$782,604,000[2]	$572,321,000	$554,872,000
Notes	Costs for expanding DWU's overall treatment plant capacity by 102 mgd (by expanding the Elm Fork WTP if room for expansion is available) would be comparable to a new plant of the same size	Cost for conveyance is included in Project Conveyance Alternative costs	Cost for conveyance is included in Project Conveyance Alternative costs

Note (1): Distribution system costs (downstream of the WTP) are not included.

Note (2): The replacement of 102 mgd capacity at Elm Fork WTP is included in this figure. If this cost is excluded, the Present Value of the 50-year life-cycle cost is $335,572,000.

7.3 Capital Cost Analysis

7.3.1 Pipeline Unit Cost

Pipeline unit costs were developed for Steel Pipe and PCCP pipe. The opinion of probable cost estimate is based on the use of PCCP pipe in rural areas and assumes a cover depth of 4-feet (above top-of-pipe). The use of Steel Pipe is assumed in urban areas with a minimal cover depth of 5-feet to top-of-pipe.

PCCP and Steel Pipe prices are based on current material prices provided by local pipe manufacturers/suppliers. In **Tables 7-1 and 7-2** material unit prices were used to estimate pipeline construction cost.

Table 7-1
Pipeline Unit Costs - Steel Pipe

Internal Diameter	CL150 $/LF	CL200 $/LF
60"	$ 288	$ 307
72"	385	411
84"	497	535
96"	650	700
108"	819	924

Note: Unit prices for Steel pipe are supplier's prices and do not include general contractor's markup for O&P.
A 10% markup for overhead and profit was applied to material prices.

Table 7-2
Pipeline Unit Costs - PCCP Pipe

Internal Diameter	CL150 $/LF	CL200 $/LF
60"	$ 282	$ 310
72"	344	380
84"	457	511
96"	658	716
!08"	819	880

Note: Unit prices for PCCP pipe are supplier's prices and do not include general contractor's markup for O&P.
A 10% markup for overhead and profit was applied to material prices.

Pipe installation (pipe assembly, excavation, bedding and backfill) costs were developed using RS Means Cost Work; unit costs were indexed to Dallas/Fort Worth for 3rd Quarter 2008. It was assumed that the project would be constructed using non-union labor. Unit prices were developed based on an average production rate in rural areas ranging from 400 LF per day for 72-inch pipe to 250 LF per day for 108-inch pipe. Excavation and backfill costs were projected based on equipment and crew requirements. Backfill material in the pipe zone was assumed to be crushed rock (1 ft below bottom of pipe to 1 ft above top of pipe). Trench width in the pipe zone was assumed to be OD + 4 ft. Above the pipe zone, it was assumed that side slopes would be laid back at 2:1. Trench boxes are assumed to be used for trench protection in the pipe zone in urban areas.

The cost estimate assumes an "Urban" classification for all pipelines within City limits. Urban areas were identified from areal maps and GIS. Urban areas were divided into "Low Urban", "Medium Urban", and "Heavy Urban", where varying production rates were assumed for each classification. In undeveloped urban areas or

areas that are lightly populated (low density), a Low Urban rating was assigned. These areas have few visible surface constraints but may require relocation and/or protection of existing underground utilities since the work is within populated areas. A Medium Urban rating was assigned to portions of the alignment in areas having a moderate level of residential, commercial and industrial development. A Heavy Urban rating was assigned to densely developed areas that will require a large amount of surface restoration and likely involve a high degree of utility relocations.

It was assumed that the production rate for Low Urban was the same as Rural since the surface conditions are similar. The production rate for Medium Urban was assumed to 2/3 of Low Urban or Rural. Production in Heavy Urban areas was assumed to be half the rate as Low Urban. A factor was also applied to construction cost in urban areas to cover the cost of utility relocations. An additional 5% was applied to Medium Urban and 10% was applied to Heavy Urban.

Table 7-3
Pipeline Lengths within Rural and Urban Classifications

Pipe Segment	Rural (mi)	Low Urban (mi)	Medium Urban (mi)	Heavy Urban (mi)	Special Crossings / Tunnel	Total
3PL	75.1	30.7	10.7	1.7	10.5	128.7
SPL (Urban)	94.0	27.4	4.9	--	1.2	127.4
SPL (Rural)	118.7	7.6	1.9	--	1.1	129.3

Note: Lengths represent main transmission line, not interconnections (Richland-Chambers to Cedar Creek, Southern Pipeline to Joe Pool, Joe Pool to Bachman WTP)

Costs were developed for soft soil and hard soil conditions. It was assumed that pre-trenching would be required in areas having hard soil conditions. Pre-trenching would involve the use of large trenching equipment (wheel type trenchers) to rip through hard material (weathered shale, etc.). Typically a 3 foot wide pass would be made on each side of the trench and an excavator (hydraulic track-hoe) would be used to excavate out the center strip. Once the soil is ripped and removed from the trench it is then placed back in the trench until the time of pipe installation. This allows for easy excavation during pipe installation.

To cover appurtenances – isolation valves, air release and blow off valves, etc., a factor of 1.10 was applied to pipe construction costs. Costs for mobilization and other general requirements are also included in this factor.

7.3.2 Pump Station Costs

Pump Station pricing was developed from bid tabs of similar size projects with similar pump and piping configurations (comparable type, size and number of pumps). Costs for pumps, motors and drives were estimated based on current pricing provided by manufactures. Costs for pump suction and discharge piping (including headers and yard piping) and valves were estimated using bid tabs from past TRWD projects and inflated based on US Bureau of Reclamation and ENR escalation factors.

The following escalation rates were applied.

U.S. Bureau of Reclamation Construction Index for Pumping Stations	
Pumping Plants	5.20%
Structural Improvements	6.09%
Equipment – General	4.33%
Pumps	4.69%
Electrical (sub-stations)/ Misc. Equip	3.49%
Steel Pipe	4.90%

The use of horizontal split-case pumps was assumed at booster pump stations. It was also assumed that half the pumps at booster pump stations will be equipped with variable frequency drives (VFDs). Horizontal split-case pumps were assumed to be between 30,000 GPM to 40,000 GPM each (approximate pump suction and discharge size = 42" x 36"). Vertical turbine pumps (can-pumps) were assumed at lake-intake pump stations, each equipped with a VFD. Vertical turbine pump sizes were assumed to average 20,000 GPM each.

Costs for power supply to the pump stations were not explicitly calculated because of the lack of detailed information needed to calculate this variable.

7.3.3 Ground Storage Tanks

Ground storage was assumed to be 5% of total daily max flow. Estimated tank costs are based on the use of pre-stressed concrete wall tanks; tanks were assumed to be uncovered (open-top). Tanks were assumed to serve pump suction requirements and also provide storage for surge control. Tank prices were obtained from local manufactures.

7.3.4 Easements and Real Estate

Easements and property costs were assumed to be $15,000 per acre for rural and $70,000 per acre for urban areas. 140 ft permanent easements were assumed for all

pipelines. Pump station sites were assumed to be 10 acres and outlet facilities at lake discharge locations were assumed to be 5 acres.

7.4 Feasibility Level Opinions of Probable Cost Tables

Table 7-4
Southern "Rural" Pipeline

Segment	Diameter (inches)	Design Flow (mgd)	Length (mi)	Land Cost	Total Cost (2008 Dollar)	Original Phase 1 Estimate Cost	Original Phase 1 Length (mi)
Palestine to Cedar Creek	78	153	38.3	$10,000,000	$ 262,000,000	$1,120,000,000	135.4
Cedar Creek to Joe Pool Turnout	108	325	62.5	$16,000,000	$784,000,000		
Joe Pool Turnout to Benbrook	84	197	28.3	$9,000,000	$227,000,000		
Interconnection to Joe Pool Vicinity	72	128	7.4	$2,000,000	$38,000,000	$135,000,000	16.0
Richland-Chambers to Cedar Creek Interconnection	54	70	12.2	$3,000,000	$74,000,000	$93,000,000	15.2
Total	--	--	148.7	$41,000,000	$1,386,000,000	$1,355,000,000	171.1

Note: "Original Phase 1 Estimate Costs" were based on Region C unit cost parameterizations (land, pipe, etc.) and different assumptions on pipeline needs and lengths. See Phase 1 report for details.

Table 7-5
Southern "Urban" Pipeline

Segment	Diameter (inches)	Design Flow (mgd)	Length (mi)	Land Cost	Total Cost (2008 Dollar)	Original Phase 1 Estimate Cost	Original Phase 1 Length (mi)
Palestine to Cedar Creek	78	153	38.3	$10,000,000	$262,000,000	$1,120,000,000	135.4
Cedar Creek to Joe Pool Turnout	108	325	64.4	$18,000,000	$797,000,000		
Joe Pool Turnout to Benbrook	84	197	24.5	$10,000,000	$226,000,000		
Interconnection to Joe Pool Vicinity	72	128	1.6	$ -	$11,000,000	$135,000,000	16.0
Richland-Chambers to Cedar Creek Interconnection	54	70	12.2	$ 3,000,000	$74,000,000	$93,000,000	15.2
Total	--	--	141.0	$42,000,000	$1,371,000,000	$1,355,000,000	171.1

Note: "Original Phase 1 Estimate Costs" were based on Region C unit cost parameterizations (land, pipe, etc.) and different assumptions on pipeline needs and lengths. See Phase 1 report for details.

Table 7-6
Third Pipeline

Segment	Diameter (inches)	Design Flow (mgd)	Length (mi)	Land Cost	Total Cost (2008 Dollar)	Original Phase 1 Estimate Cost	Original Phase 1 Length (mi)
Palestine to Cedar Creek	78	153	38.3	$10,000,000	$262,000,000	$177,000,000	35.1
Cedar Creek to Ennis	96	255	32.3	$ 9,000,000	$327,000,000	$224,000,000	25.6
Ennis to Joe Pool Turnout	108	325	32.3	$15,000,000	$472,000,000	$562,000,000	48.3
Joe Pool Turnout to RHWTP	84	197	16.3	$ 9,000,000	$126,000,000		
RHWTP to Benbrook	84	197	9.2	$ 2,000,000	$187,000,000	N/A	0.0
RC to Ennis Alignment	54	70	29.7	$ 8,000,000	$141,000,000	$109,000,000	29.6
Total	--	--	158.2	$53,000,000	$1,515,000,000	$1,084,000,000	146.7

Note: "Original Phase 1 Estimate Costs" were based on Region C unit cost parameterizations (land, pipe, etc.) and different assumptions on pipeline needs and lengths. See Phase 1 report for details.

Table 7-7
Interconnection to Bachman WTP

Segment	Diameter (inches)	Design Flow (mgd)	Length (mi)	Land Cost	Total Cost (2008 Dollar)	Original Phase 1 Estimate Cost	Original Phase 1 Length (mi)
Joe Pool Lake Vicinity to Bachman WTP	78	128	27.8	$12,000,000	$211,000,000	$171,000,000	27.8

Note: "Original Phase 1 Estimate Costs" were based on Region C unit cost parameterizations (land, pipe, etc.) and different assumptions on pipeline needs and lengths. See Phase 1 report for details.

Table 7-8
Capital Cost Summary

Alternative	Total OPC (2008)	Total OPC (2015)
Southern Corridor - Rural Alignment	$1,386,000,000	1,597,000,000
Southern Corridor - Urban Alignment	$1,371,000,000	1,579,000,000
Third Pipeline	$1,515,000,000	1,744,000,000
Joe Pool to Bachman WTP	$211,000,000	242,000,000

Note: All costs are based on 3rd Quarter 2008 prices and then escalated to 2015 using an escalation rate of 3.46% per year.

7.5 Life Cycle Cost Analysis

This life cycle cost analysis is based on the same methodology used in the original Phase 1 analysis and documented previously (and therefore not repeated herein). Because the methodology is unchanged, the variables that require description are the energy consumption (cost factors are unchanged) and phasing potential (deferring capital cost expenditures). Energy consumption is addressed in Section 6 of this report and phasing is described in Section 5. Therefore, this section summarizes the results of the life cycle cost analyses and defers to the other sections of this report to describe methodologies or variables.

Table 7-9
Life Cycle Cost Analysis Results

Alternative	Present Worth of 50-year Life-Cycle Cost	Present Worth of 50-year Life-Cycle WITH PHASING
Southern Corridor - Rural Alignment	$ 2,435,000,000	$ 2,404,000,000
Southern Corridor - Urban Alignment	2,415,000,000	2,394,000,000
Third Pipeline	2,580,000,000	2,499,000,000
Joe Pool to Bachman WTP	263,000,000	N/A

As used in the original Phase 1 life cycle cost analyses, energy cost is $0.084/kwh and decreases at a 0.1% rate over time (based on the US Department of Energy Annual Energy Outlook 2008 Energy Prices by Sector and Source forecast).

Section 8
Comparison of Alternatives

8.1 Overview of Alternatives Comparison

One of the primary purposes of the ongoing Raw Water Transmission System Integration Study was to further refine the alternative pipeline corridors identified in the initial project viability assessment summary report dated July 2008. The integrated transmission configurations included in the initial project viability assessment can best be described as the Third Pipeline which would be generally located within the existing TRWD right of way, and a Southern Pipeline that would be located within a new corridor south of the 3rd pipeline alignment in more rural areas with adequate width to accommodate future water supply transmission facilities. The objective of the current analysis was to provide the City of Dallas and the Tarrant Regional Water District one project configuration that meets the needs of both parties.

The two basic raw water transmission configurations, the Third Pipeline and the Southern pipeline, described in detail in Section 2 of this report, were evaluated based on several quantitative and qualitative criteria identified during project workshop meetings and included:

- Capital Cost
- Operating Cost
- Supply Reliability
- Phasing Potential
- Water Sharing Potential
- Redundancy
- Future Planning Considerations

Table 8-1 provides a side by side comparison of these criteria for the Third Pipeline and Southern Pipeline corridors.

Table 8-1
Corridor Comparison Matrix

	3rd Pipeline	Southern Pipeline	Comments
Capital Cost	$1.52 Billion	$1.38 Billion	Significant cost saving potential with the Southern pipeline corridor
Average Annual Operating Cost	$47 Million/yr	$47 Million/yr	No appreciable difference
Supply Reliability	-	-	No appreciable difference
Construction Phasing Potential	Slightly greater		Timing of Lake Palestine connection to be addressed in MOU. Some western pipeline segments may be phased under either alternative
Water Sharing Potential	-	-	No appreciable difference
Redundancy	Pumps would operate from the same electrical source as existing TRWD facilities and have the same spatial vulnerabilities as existing pipelines	Alignment would isolate new flows from existing facilities, provide opportunities for separate electrical supplies, and isolate new pipeline from older existing pipeline	The Southern Pipeline provides power supply redundancy and isolation from existing pipeline facilities and would lessen the risk of catastrophic failure.
Future Planning	This corridor would utilize existing right-of-way to its fullest extent and includes the acquisition of additional easements in a separate corridor for future needs.	This option includes the acquisition of sufficient right-of-way such that after construction, each corridor will have space available for future needs.	The Southern Pipeline Corridor provides the best opportunity to reserve a water supply pipeline corridor for future East Texas supplies.

Third Pipeline

The TRWD has long planned to build a Third Pipeline within the existing 130' ROW that was purchased many years ago. One of the primary benefits of this alignment is that it represents the most direct route to the upper reach of Joe Pool Lake minimizing the pipeline length for raw water supplies for treatment and delivery into Dallas' western distribution system and to TRWD customer treatment plants. It also represents an existing ROW that could minimize scheduling delays associated with securing additional easements for a future integrated water transmission system.

Another benefit associated with this existing ROW is that existing TRWD facilities could be utilized (or expanded) to reduce the cost of connecting to terminal storage or water treatment plants. The existing pump stations at Ennis and Waxahachie were built with the planned Third Pipeline in mind and have VFD's and capacity to accommodate a new line. Also with the Third Pipeline in place, the system friction head would be lowered in the short term because water would be distributed between three large diameter pipelines instead of two, lowering power costs. Not only would the operating costs be reduced, it would delay the need to add pumping facilities until the system water demand increases to the point where the friction head requires that these additional facilities be added.

To accommodate planning for connection of future water supplies to the East of Lake Palestine, the purchase of additional ROW was considered in this analysis. Both integrated conveyance alternatives include the purchase of ROW sufficient for two pipelines. This reservation of a pipeline corridor for future use would ensure that additional urban growth in the North Texas area would not preclude or hinder the development of these East Texas supplies at a later date. Thus this ROW reservation would help maintain the viability of future water supplies from East Texas but would raise issues associated with the need to revise regional water plans and the advanced acquisition of property rights for a long range planned facility.

In terms of estimated capital, the Third Pipeline has an opinion of probable cost of $1.52 billion based upon 3rd quarter 2008 costing data while the Southern Pipeline opinion of probable cost is $1.38 billion, a difference of $140 million clearly favoring the Southern Pipeline concept.

No capital or operating cost allocation responsibility has been assigned to the two parties at this time to ensure that the comparison of approaches is unbiased. It is anticipated that both Dallas and TRWD will have full cost responsibility for certain facilities in either approach and that some additional facilities not included in the above opinions of probable cost may be necessary for one or both parties. Subsequent discussions between the parties will define cost, ownership, operations, and other terms that will be included in a joint agreement if a clear business case supports an integrated system.

Another important consideration in the comparison of the two alternative integrated system approaches is the potential to delay or phase certain aspects of the overall concepts and to therefore spread the associated capital costs over time. While there may also be opportunities to construct or expand pump stations and other ancillary facilities over time, our analysis was confined mainly to pipeline reaches, assuming that the opportunity for cost savings would be more substantial with respect to the pipelines. Both integrated system approaches were modeled to examine phasing strategies that would not reduce the firm supply reliability. Since it is estimated that Lake Palestine would not be needed on a firm basis until 2023, both the Third Pipeline and the Sothern Pipeline options could defer the connection of Lake Palestine to Cedar Creek Reservoir until that time.

he Third Pipeline option offers an additional opportunity to defer the connection between the Rolling Hills WTP and Lake Benbrook, perhaps as late as 2030, thereby spreading that estimated capital cost of more than $200 million over an additional 15 years. Generally the Third Pipeline offers greater flexibility in terms of overall phasing potential.

The Third Pipeline co-located parallel to TRWD's existing Cedar Creek and Richland-Chambers pipelines within a relatively narrow 130' wide corridor would represent a significant risk in terms of any catastrophic pipeline rupture, or power outages at critical pump stations along the way between the supply sources and points of delivery. These types of failures could potentially disrupt the entire water delivery to TRWD from eastern supplies for an extended period endangering most of Tarrant County's drinking water needs. The Dallas water system has more pathways for other backup supplies in the event of such a catastrophic failure in the Third Pipeline configuration and would not bear the same consequences of this risk.

An integrated water transmission system approach would provide water sharing potential between Dallas and TRWD to share its respective supply with the other when a surplus is available thus either deferring capital investments that would otherwise be needed in the absence of a joint system, or to manage operational costs by minimizing the use of supplies that are more distant when closer supplies are adequate. Both the Third Pipeline alternative and the Southern Pipeline alternative provide these potential benefits with no clear distinguishing differences.

Southern Pipeline

The Southern Pipeline configuration would provide a number of both short- and long-term benefits. The long-term benefits relate to the future use of East Texas water supplies. This project approach would ensure that adequate right of way would be acquired in the near term to reserve a corridor for future needs. Siting future water transmission facilities will become increasingly more difficult in the Dallas/Fort Worth area as existing rural land is quickly being converted to urban uses as the population of the metroplex is poised to double over the next 50 years. Rural land prices are an order-of-magnitude less expensive than urban land prices, construction in rural areas is faster and less expensive. Securing this ROW now will make future integration between the Dallas and TRWD systems much easier and will facilitate connecting new supplies from the east.

The Southern Pipeline route also provides compelling short-term redundancy and flexibility. If a failure were to occur in the existing TRWD eastern transmission facilities, the Southern Pipeline configuration would provide the flexibility to continue providing Tarrant County water deliveries while repairs were underway. Significantly, the Southern Pipeline approach offers the potential to diversify power supplies to vital pumping facilities.

In terms of joint system capital costs, the Southern Pipeline offers substantially lower initial investment cost, approximately $140 million, while providing similar average operating costs as the Third Pipeline.

8.2 Recommendation of Preferred Corridor

Based upon the analysis done to date, it is recommended that the general Southern Pipeline configuration be the basis of further engineering, institutional arrangement framework efforts, and project development studies and that the Southern Pipeline be the basis of subsequent considerations related to the efficacy of an integrated system approach versus separate individual water supply projects. The long term planning considerations coupled with the capital cost savings and operational redundancy for TRWD provides the most value for both agencies without sacrificing water supply reliability or construction phasing opportunities.

Section 9
Project Delivery Plan and Schedule

9.1 Tasks

The primary purpose of developing the project delivery plan and schedule was to outline the tasks necessary to provide Dallas and TRWD a more thorough understanding of the technical, financial, and institutional issues associated with advancing an integrated raw water transmission system toward implementation, should an adequate business case exist for each party.

The project delivery plan and schedule is a dynamic document intended to be updated as the project progresses and is tailored to project goals. It is therefore constructed around the City of Dallas and TRWD primary goals **to ensure 100% water supply reliability for their respective customers** by delivering additional unconnected water supplies. Significant work elements continue to be developed to support the June 2009 decision-point goal to provide both governing and advisory bodies with sufficient information to understand the ramifications of a joint undertaking. This project delivery plan focuses on identification of the complex institutional, contractual, funding, permitting, and engineering and construction issues of proposed integrated raw water transmission facilities.

While important evaluations continue regarding all aspects of the integrated water transmission project, this preliminary project plan and schedule assumes the following:

- Project development work unrelated to the Go/No Go decision will be limited prior to July 2009, focusing only on those tasks on the project's critical path or issues related to independent facilities that would, absent consensus on joint facilities, be pursued by each system concurrently.

- Conceptual Design and the development of a design documentation report would commence after a contractual decision by project partners, currently projected for early 2010.

- The design documentation effort would focus on documenting design decisions to support detailed design, and provide consistency in the specification of materials and design approaches. This preliminary design approach will permit more flexibility in terms of project delivery methods that might ultimately be used for detailed design and construction.

- Design decisions related to the TRWD Cedar Creek constructed wetland project (by others) will be closely coordinated with the conceptual design and permitting of the Cedar Creek Reservoir water intake design and construction.

- The design and construction timeline outlined in the preliminary project schedule is predicated upon a traditional project delivery approach, design/bid/build.

Consideration of project phasing, project packaging, and alternate project delivery will be more fully developed as the institutional issues and project funding are considered. In addition, subsequent project plan updates will consider the available delivery capacity of the engineering and construction sectors and the large diameter pipe and other critical materials manufacturing capacity.

9.2 Schedule

The project plan schedule has been developed in Microsoft Project and is attached. The primary project delivery tasks and their generalized timeframes are:

- Ongoing Development and Approval of Institutional & Financial Framework (1/2009 – 1/2010)
- Ongoing project development studies (1/2009 – 1/2010)
- Route Study and Pump Station Site Alternatives (2/2009 – 1/2010)
- Environmental Analysis and Permitting (6/2009 – 6/2012)
- Real Estate Acquisition (Start planning January 2010, finish by January 2014)
- Preliminary design and design documentation report (Start February 2010, 12 month duration)
- Detailed Design (Start January 2011, 24 month duration)
- Construction (Start June 2013, 3.5 year duration; dependent on construction sequencing and phasing opportunities)

PROJECT BUDGET - Entity Name - Tarrant Regional Water District (City of Dallas)						
Uses	**TWDB Funds Series 1**	**TWDB Funds Series 2**	**TWDB Funds Series 3**	**Total TWDB Cost**	**Other Funds**	**Total Cost**
Construction						
Construction	$94,490,000	$0	$0	$94,490,000	$13,030,000	$107,520,000
Subtotal Construction	**$94,490,000**	**$0**	**$0**	**$94,490,000**	**$13,030,000**	**$107,520,000**
Basic Engineering Fees						
Planning +	$0	$0	$0	$0	$0	$0
Design	$720,000	$0	$0	$720,000	$8,100,000	$8,820,000
Construction Engineering	$1,680,000	$0	$0	$1,680,000	$6,750,000	$8,430,000
Basic Engineering Other **_____	$0	$0	$0	$0	$0	$0
Subtotal Basic Engineering Fees	**$2,400,000**	**$0**	**$0**	**$2,400,000**	**$14,850,000**	**$17,250,000**
Special Services						
Application	$0	$0	$0	$0	$0	$0
Environmental	$0	$0	$0	$0	$0	$0
Water Conservation Plan	$0	$0	$0	$0	$0	$0
I/I Studies/Sewer Evaluation	$0	$0	$0	$0	$0	$0
Surveying	$1,310,000	$0	$0	$1,310,000	$0	$1,310,000
Geotechnical	$0	$0	$0	$0	$0	$0
Testing	$740,000	$0	$0	$740,000	$590,000	$1,330,000
Permits	$0	$0	$0	$0	$0	$0
Inspection	$0	$0	$0	$0	$0	$0
O&M Manual	$0	$0	$0	$0	$0	$0
Project Management (by engineer)	$7,940,000	$0	$0	$7,940,000	$2,240,000	$10,180,000
Pilot Testing	$0	$0	$0	$0	$0	$0
Water Distribution Modeling	$0	$0	$0	$0	$0	$0
Special Services Other **_____	$0	$0	$0	$0	$0	$0
Subtotal Special Services	**$9,990,000**	**$0**	**$0**	**$9,990,000**	**$2,830,000**	**$12,820,000**
Other						
Administration	$10,850,000	$0	$0	$10,850,000	$12,110,000	$22,960,000
Land/Easements Acquisition	$12,770,000	$0	$0	$12,770,000	$12,030,000	$24,800,000
Water Rights Purchase (If Applicable)	$0	$0	$0	$0	$0	$0
Capacity Buy-In (If Applicable)	$0	$0	$0	$0	$0	$0
Project Legal Expenses	$0	$0	$0	$0	$0	$0
Other **	$0	$0	$0	$0	$0	$0
Subtotal Other Services	**$23,620,000**	**$0**	**$0**	**$23,620,000**	**$24,140,000**	**$47,760,000**
Fiscal Services						
Financial Advisor	$0	$0	$0	$0	$0	$0
Bond Counsel	$0	$0	$0	$0	$0	$0
Issuance Cost	$420,000	$0	$0	$420,000	$310,000	$730,000
Bond Insurance/Surety	$0	$0	$0	$0	$0	$0
Fiscal/Legal	$0	$0	$0	$0	$0	$0
Capitalized Interest	$0	$0	$0	$0	$0	$0
Bond Reserve Fund	$8,170,000	$0	$0	$8,170,000	$6,970,000	$15,140,000
Loan Origination Fee	$0	$0	$0	$0	$0	$0
Other **	$0	$0	$0	$0	$0	$0
Subtotal Fiscal Services	**$8,590,000**	**$0**	**$0**	**$8,590,000**	**$7,280,000**	**$15,870,000**
Contingency						
Contingency	$910,000	$0	$0	$910,000	$4,870,000	$5,780,000
Subtotal Contingency	**$910,000**	**$0**	**$0**	**$910,000**	**$4,870,000**	**$5,780,000**
TOTAL COSTS	**$140,000,000**	**$0**	**$0**	**$140,000,000**	**$67,000,000**	**$207,000,000**

Other ** description must be entered

+ For Planning applications under the EDAP Program, please break down Planning costs as follows:

Category A			0
Category B			0
Category C			0
Category D			0
Total Planning Costs	0	0	0

PROJECT BUDGET - Entity Name - Tarrant Regional Water District - TRWD Bond						
Uses	**TWDB Funds Series 1**	**TWDB Funds Series 2**	**TWDB Funds Series 3**	**Total TWDB Cost**	**Other Funds**	**Total Cost**
Construction						
Construction	$217,630,000	$0	$0	$217,630,000	$123,270,000	$340,900,000
Subtotal Construction	**$217,630,000**	**$0**	**$0**	**$217,630,000**	**$123,270,000**	**$340,900,000**
Basic Engineering Fees						
Planning +	$0	$0	$0	$0	$0	$0
Design	$1,250,000	$0	$0	$1,250,000	$0	$1,250,000
Construction Engineering	$4,540,000	$0	$0	$4,540,000	$3,970,000	$8,510,000
Basic Engineering Other ** _____	$0	$0	$0	$0	$0	$0
Subtotal Basic Engineering Fees	**$5,790,000**	**$0**	**$0**	**$5,790,000**	**$3,970,000**	**$9,760,000**
Special Services						
Application	$0	$0	$0	$0	$0	$0
Environmental	$0	$0	$0	$0	$0	$0
Water Conservation Plan	$0	$0	$0	$0	$0	$0
I/I Studies/Sewer Evaluation	$0	$0	$0	$0	$0	$0
Surveying	$1,430,000	$0	$0	$1,430,000	$0	$1,430,000
Geotechnical	$0	$0	$0	$0	$0	$0
Testing	$2,090,000	$0	$0	$2,090,000	$1,800,000	$3,890,000
Permits	$0	$0	$0	$0	$0	$0
Inspection	$0	$0	$0	$0	$0	$0
O&M Manual	$0	$0	$0	$0	$0	$0
Project Management (by engineer)	$14,910,000	$0	$0	$14,910,000	$6,700,000	$21,610,000
Pilot Testing	$0	$0	$0	$0	$0	$0
Water Distribution Modeling	$0	$0	$0	$0	$0	$0
Special Services Other ** _____	$0	$0	$0	$0	$0	$0
Subtotal Special Services	**$18,430,000**	**$0**	**$0**	**$18,430,000**	**$8,500,000**	**$26,930,000**
Other						
Administration	$15,960,000	$0	$0	$15,960,000	$16,300,000	$32,260,000
Land/Easements Acquisition	$24,660,000	$0	$0	$24,660,000	$17,970,000	$42,630,000
Water Rights Purchase (If Applicable)	$0	$0	$0	$0	$0	$0
Capacity Buy-In (If Applicable)	$0	$0	$0	$0	$0	$0
Project Legal Expenses	$0	$0	$0	$0	$0	$0
Other **	$0	$0	$0	$0	$0	$0
Subtotal Other Services	**$40,620,000**	**$0**	**$0**	**$40,620,000**	**$34,270,000**	**$74,890,000**
Fiscal Services						
Financial Advisor	$0	$0	$0	$0	$0	$0
Bond Counsel	$0	$0	$0	$0	$0	$0
Issuance Cost	$790,000	$0	$0	$790,000	$650,000	$1,440,000
Bond Insurance/Surety	$0	$0	$0	$0	$0	$0
Fiscal/Legal	$0	$0	$0	$0	$0	$0
Capitalized Interest	$0	$0	$0	$0	$0	$0
Bond Reserve Fund	$15,120,000	$0	$0	$15,120,000	$14,380,000	$29,500,000
Loan Origination Fee	$0	$0	$0	$0	$0	$0
Other **	$0	$0	$0	$0	$0	$0
Subtotal Fiscal Services	**$15,910,000**	**$0**	**$0**	**$15,910,000**	**$15,030,000**	**$30,940,000**
Contingency						
Contingency	$1,620,000	$0	$0	$1,620,000	$9,660,000	$11,280,000
Subtotal Contingency	**$1,620,000**	**$0**	**$0**	**$1,620,000**	**$9,660,000**	**$11,280,000**
TOTAL COSTS	**$300,000,000**	**$0**	**$0**	**$300,000,000**	**$194,700,000**	**$494,700,000**

Other ** description must be entered

+ For Planning applications under the EDAP Program, please break down Planning costs as follows:

Category A			0
Category B			0
Category C			0
Category D			0
Total Planning Costs	0	0	0

TWDB-1202
Revised 2/22/2011

PROJECTED DRAW SCHEDULE FOR

Template must be downloaded and saved prior to printing.

Entity Name: Tarrant Regional Water District - DWU

Project No.:

Please complete all areas shaded in blue.

Gray shaded areas will compute automatically.

Date Prepared: May 1 2015

By my signature, I acknowledge I have reviewed the project draw schedule incorporated herein and to the best of my knowledge it is an accurate reflection of the anticipated project financial needs at this time.

	Print Name	Signature	Date
Owner:	Sandra Newby		
Engineer:	Ed Weaver		
Financial Advisor:	Laura Alexander		

Financial Advisor signature needed prior to closing only.

Entires must include all Fiscal Costs associated with the project except contingency.
Show the contingency in the month immediately after completion of the project.
Entires must match budgeted amounts.

Source of Funds		DWSRF	EDAP	SWIFT	Total		Cummulative	Debt Service
Loan/Grant #					Project Costs	Total Draws	Draws	Maturities
Loan/Grant Amount			$ -	$ 140,000,000	$140,000,000			
Actual or Estimated Closing Date	Nov-15							
	Dec-15			$ 8,590,000		$ 8,590,000	$ 8,590,000	
	Jan-16	$ -		$ 74,790,000		$ 74,790,000	$ 83,380,000	
	Feb-16			$ -		$ -	$ 83,380,000	
	Mar-16			$ 2,840,000		$ 2,840,000	$ 86,220,000	
	Apr-16			$ 7,940,000		$ 7,940,000	$ 94,160,000	
	May-16			$ 20,000,000		$ 20,000,000	$ 114,160,000	
	Jun-16			$ 4,300,000		$ 4,300,000	$ 118,460,000	
	Jul-16					$ -	$ 118,460,000	
	Aug-16					$ -	$ 118,460,000	
	Sep-16					$ -	$ 118,460,000	
	Oct-16					$ -	$ 118,460,000	
	Nov-16					$ -	$ 118,460,000	

Dec-16		$ -	$ -	$ 118,460,000	
Jan-17		$ 4,300,000	$ 4,300,000	$ 122,760,000	
Feb-17	$ -		$ -	$ 122,760,000	
Mar-17	$ -		$ -	$ 122,760,000	
Apr-17	$ -		$ -	$ 122,760,000	
May-17	$ -		$ -	$ 122,760,000	
Jun-17	$ -	$ 4,300,000	$ 4,300,000	$ 127,060,000	
Jul-17	$ -		$ -	$ 127,060,000	
Aug-17	$ -		$ -	$ 127,060,000	
Sep-17	$ -		$ -	$ 127,060,000	
Oct-17			$ -	$ 127,060,000	
Nov-17			$ -	$ 127,060,000	
Dec-17		$ 4,300,000	$ 4,300,000	$ 131,360,000	
Jan-18			$ -	$ 131,360,000	
Feb-18			$ -	$ 131,360,000	
Mar-18			$ -	$ 131,360,000	
Apr-18			$ -	$ 131,360,000	
May-18			$ -	$ 131,360,000	
Jun-18		$ 4,300,000	$ 4,300,000	$ 135,660,000	
Jul-18			$ -	$ 135,660,000	
Aug-18			$ -	$ 135,660,000	
Sep-18			$ -	$ 135,660,000	
Oct-18			$ -	$ 135,660,000	
Nov-18			$ -	$ 135,660,000	
Dec-18		$ 4,340,000	$ 4,340,000	$ 140,000,000	
Jan-19			$ -	$ 140,000,000	
Feb-19			$ -	$ 140,000,000	
Mar-19			$ -	$ 140,000,000	
Apr-19			$ -	$ 140,000,000	
May-19			$ -	$ 140,000,000	
Jun-19			$ -	$ 140,000,000	
Jul-19			$ -	$ 140,000,000	
Aug-19			$ -	$ 140,000,000	
Sep-19			$ -	$ 140,000,000	
Oct-19			$ -	$ 140,000,000	
Nov-19			$ -	$ 140,000,000	
Dec-19			$ -	$ 140,000,000	
Jan-20			$ -	$ 140,000,000	
Feb-20			$ -	$ 140,000,000	

Mar-20				$ -	$ 140,000,000
Apr-20				$ -	$ 140,000,000
May-20				$ -	$ 140,000,000
Jun-20				$ -	$ 140,000,000
Jul-20				$ -	$ 140,000,000
Aug-20				$ -	$ 140,000,000
Sep-20				$ -	$ 140,000,000
Oct-20				$ -	$ 140,000,000
Nov-20				$ -	$ 140,000,000
Dec-20				$ -	$ 140,000,000
Jan-21				$ -	$ 140,000,000
Feb-21				$ -	$ 140,000,000
Mar-21				$ -	$ 140,000,000
Apr-21				$ -	$ 140,000,000
May-21				$ -	$ 140,000,000
Jun-21				$ -	$ 140,000,000
Jul-21				$ -	$ 140,000,000
Aug-21				$ -	$ 140,000,000
Sep-21				$ -	$ 140,000,000
Oct-21				$ -	$ 140,000,000
Nov-21				$ -	$ 140,000,000
Dec-21				$ -	$ 140,000,000
Jan-22				$ -	$ 140,000,000

TWDB-1202
Revised 2/22/2011

PROJECTED DRAW SCHEDULE FOR

Template must be downloaded and saved prior to printing.

Entity Name: **Tarrant Regional Water District**

Project No.:

Please complete all areas shaded in blue.

Gray shaded areas will compute automatically.

Date Prepared: May 1 2015

By my signature, I acknowledge I have reviewed the project draw schedule incorporated herein and to the best of my knowledge it is an accurate reflection of the anticipated project financial needs at this time.

	Print Name	Signature	Date
Owner:	Sandra Newby		
Engineer:	Ed Weaver		
Financial Advisor:	Laura Alexander		

Financial Advisor signature needed prior to closing only.

Entires must include all Fiscal Costs associated with the project except contingency.
Show the contingency in the month immediately after completion of the project.
Entires must match budgeted amounts.

Source of Funds		DWSRF	EDAP	SWIFT	Total			
Loan/Grant #					Project Costs	Total Draws	Cummulative Draws	Debt Service Maturities
Loan/Grant Amount			$ -	$ 300,000,000	$300,000,000			
Actual or Estimated Closing Date	Nov-15							
	Dec-15			$ 15,910,000		$ 15,910,000	$ 15,910,000	
	Jan-16	$ -		$ 1,250,000		$ 1,250,000	$ 17,160,000	
	Feb-16			$ -		$ -	$ 17,160,000	
	Mar-16			$ 202,700,000		$ 202,700,000	$ 219,860,000	
	Apr-16			$ 14,910,000		$ 14,910,000	$ 234,770,000	
	May-16					$ -	$ 234,770,000	
	Jun-16			$ 7,300,000		$ 7,300,000	$ 242,070,000	
	Jul-16					$ -	$ 242,070,000	
	Aug-16					$ -	$ 242,070,000	
	Sep-16					$ -	$ 242,070,000	
	Oct-16					$ -	$ 242,070,000	
	Nov-16					$ -	$ 242,070,000	

Dec-16				$ 21,560,000		$ 21,560,000	$ 263,630,000		
Jan-17				$ 7,300,000		$ 7,300,000	$ 270,930,000		
Feb-17		$ -				$ -	$ 270,930,000		
Mar-17		$ -				$ -	$ 270,930,000		
Apr-17		$ -				$ -	$ 270,930,000		
May-17		$ -				$ -	$ 270,930,000		
Jun-17		$ -		$ 7,300,000		$ 7,300,000	$ 278,230,000		
Jul-17		$ -				$ -	$ 278,230,000		
Aug-17		$ -				$ -	$ 278,230,000		
Sep-17						$ -	$ 278,230,000		
Oct-17						$ -	$ 278,230,000		
Nov-17						$ -	$ 278,230,000		
Dec-17				$ 7,300,000		$ 7,300,000	$ 285,530,000		
Jan-18						$ -	$ 285,530,000		
Feb-18						$ -	$ 285,530,000		
Mar-18						$ -	$ 285,530,000		
Apr-18						$ -	$ 285,530,000		
May-18						$ -	$ 285,530,000		
Jun-18				$ 7,300,000		$ 7,300,000	$ 292,830,000		
Jul-18						$ -	$ 292,830,000		
Aug-18						$ -	$ 292,830,000		
Sep-18						$ -	$ 292,830,000		
Oct-18						$ -	$ 292,830,000		
Nov-18						$ -	$ 292,830,000		
Dec-18				$ 7,170,000		$ 7,170,000	$ 300,000,000		
Jan-19						$ -	$ 300,000,000		
Feb-19						$ -	$ 300,000,000		
Mar-19						$ -	$ 300,000,000		
Apr-19						$ -	$ 300,000,000		
May-19						$ -	$ 300,000,000		
Jun-19						$ -	$ 300,000,000		
Jul-19						$ -	$ 300,000,000		
Aug-19						$ -	$ 300,000,000		
Sep-19						$ -	$ 300,000,000		
Oct-19						$ -	$ 300,000,000		
Nov-19						$ -	$ 300,000,000		
Dec-19						$ -	$ 300,000,000		
Jan-20						$ -	$ 300,000,000		
Feb-20						$ -	$ 300,000,000		

Mar-20				$ -	$ 300,000,000
Apr-20				$ -	$ 300,000,000
May-20				$ -	$ 300,000,000
Jun-20				$ -	$ 300,000,000
Jul-20				$ -	$ 300,000,000
Aug-20				$ -	$ 300,000,000
Sep-20				$ -	$ 300,000,000
Oct-20				$ -	$ 300,000,000
Nov-20				$ -	$ 300,000,000
Dec-20				$ -	$ 300,000,000
Jan-21				$ -	$ 300,000,000
Feb-21				$ -	$ 300,000,000
Mar-21				$ -	$ 300,000,000
Apr-21				$ -	$ 300,000,000
May-21				$ -	$ 300,000,000
Jun-21				$ -	$ 300,000,000
Jul-21				$ -	$ 300,000,000
Aug-21				$ -	$ 300,000,000
Sep-21				$ -	$ 300,000,000
Oct-21				$ -	$ 300,000,000
Nov-21				$ -	$ 300,000,000
Dec-21				$ -	$ 300,000,000
Jan-22				$ -	$ 300,000,000

Integrated Pipeline Program
Current Construction Schedule
TWDB

PL 10/PL 11
Start: 3/1/2016
End: 2/28/2018

DWU
Start: 1/1/2016
End: 6/1/2017

PL 9
Start: 1/3/2033
End: 7/5/2035

PL 12/PL 13/MBR
Start: 11/10/2014
End: 4/7/2017

JB4
Start: 7/1/2031
End: 7/3/2035

JB4 Bypass
Start: 3/1/2016
End: 2/28/2018

Existing TRWD Pipelines

JB3
Start: 7/21/2014
End: 2/13/2018

PL 14
Start: 1/1/2016
End: 10/31/2017

PL 15-2
Start: 7/16/2015
End: 7/19/2017

PL 15-1
Start: 5/1/2014
End: 8/6/2015

PL 17/PL 18
Start: 3/1/2016
End: 11/30/2020

JCC1 Intake
Start: 12/1/2016
End: 5/31/2019

JCC1 PS
Start: 11/29/2018
End: 6/01/2021

JB2
Start: 7/1/2026
End: 7/3/2030

PL 16
Start: 9/1/2028
End: 3/10/2031

JRC1
Start: 7/1/2028
End: 7/3/2032

PL 19-1
Start: 7/1/2020
End: 12/28/2022

PL 19-2
Start: 1/2/2022
End: 7/3/2024

LP1 Intake
Start: 7/1/2020
End: 12/29/2022

LP1 PS
Start: 7/3/2022
End: 12/31/2024

Includes Land Cost for IPL Section 9, 16, 19-2 and 19-1

Census Tracts Contained within the DWU Service Area

ID	County ID	Census Tract Name
1	113	Census Tract 166.12
2	113	Census Tract 122.11
3	113	Census Tract 124
4	113	Census Tract 165.13
5	113	Census Tract 165.14
6	113	Census Tract 165.17
7	113	Census Tract 165.18
8	113	Census Tract 165.19
9	113	Census Tract 166.05
10	113	Census Tract 166.06
11	113	Census Tract 166.07
12	113	Census Tract 166.10
13	113	Census Tract 166.11
14	113	Census Tract 136.09
15	113	Census Tract 136.10
16	113	Census Tract 136.11
17	113	Census Tract 153.06
18	113	Census Tract 154.01
19	113	Census Tract 154.03
20	113	Census Tract 154.04
21	113	Census Tract 155
22	113	Census Tract 156
23	113	Census Tract 79.14
24	113	Census Tract 136.25
25	113	Census Tract 176.05
26	113	Census Tract 116.02
27	113	Census Tract 117.01
28	113	Census Tract 117.02
29	113	Census Tract 120
30	113	Census Tract 121
31	113	Census Tract 122.04
32	113	Census Tract 122.06
33	113	Census Tract 122.07
34	113	Census Tract 118
35	113	Census Tract 122.08
36	113	Census Tract 107.03
37	113	Census Tract 107.04
38	113	Census Tract 9801
39	113	Census Tract 6.05
40	113	Census Tract 164.07
41	113	Census Tract 71.01
42	113	Census Tract 168.04
43	113	Census Tract 91.05
44	113	Census Tract 122.10

Census Tracts Contained within the DWU Service Area

ID	County ID	Census Tract Name
45	113	Census Tract 96.10
46	113	Census Tract 141.21
47	113	Census Tract 137.13
48	113	Census Tract 42.01
49	113	Census Tract 170.01
50	113	Census Tract 171.02
51	113	Census Tract 111.05
52	113	Census Tract 59.01
53	113	Census Tract 60.01
54	113	Census Tract 60.02
55	113	Census Tract 62
56	113	Census Tract 63.01
57	113	Census Tract 63.02
58	113	Census Tract 65.01
59	113	Census Tract 65.02
60	113	Census Tract 108.01
61	113	Census Tract 112
62	113	Census Tract 113
63	113	Census Tract 18
64	113	Census Tract 19
65	113	Census Tract 20
66	113	Census Tract 21
67	113	Census Tract 12.02
68	113	Census Tract 12.03
69	113	Census Tract 158
70	113	Census Tract 119
71	113	Census Tract 169.03
72	113	Census Tract 166.17
73	113	Census Tract 87.03
74	113	Census Tract 140.02
75	113	Census Tract 141.24
76	113	Census Tract 77
77	113	Census Tract 137.11
78	113	Census Tract 141.14
79	113	Census Tract 153.04
80	113	Census Tract 147.03
81	113	Census Tract 164.06
82	113	Census Tract 115
83	113	Census Tract 59.02
84	113	Census Tract 76.01
85	113	Census Tract 76.04
86	113	Census Tract 76.05
87	113	Census Tract 78.01
88	113	Census Tract 78.04

Census Tracts Contained within the DWU Service Area

ID	County ID	Census Tract Name
89	113	Census Tract 78.05
90	113	Census Tract 78.11
91	113	Census Tract 47
92	113	Census Tract 48
93	113	Census Tract 49
94	113	Census Tract 50
95	113	Census Tract 51
96	113	Census Tract 52
97	113	Census Tract 25
98	113	Census Tract 27.02
99	113	Census Tract 190.19
100	257	Census Tract 502.06
101	113	Census Tract 54
102	113	Census Tract 55
103	113	Census Tract 53
104	113	Census Tract 56
105	113	Census Tract 136.24
106	113	Census Tract 57
107	113	Census Tract 78.15
108	113	Census Tract 78.18
109	113	Census Tract 78.19
110	113	Census Tract 79.02
111	113	Census Tract 22
112	113	Census Tract 24
113	113	Census Tract 27.01
114	121	Census Tract 217.28
115	113	Census Tract 80
116	113	Census Tract 81
117	113	Census Tract 82
118	113	Census Tract 114.01
119	121	Census Tract 215.23
120	121	Census Tract 216.11
121	121	Census Tract 216.12
122	121	Census Tract 216.13
123	121	Census Tract 216.14
124	121	Census Tract 216.16
125	121	Census Tract 206.01
126	113	Census Tract 88.02
127	113	Census Tract 89
128	121	Census Tract 216.27
129	113	Census Tract 96.03
130	113	Census Tract 96.04
131	113	Census Tract 96.05
132	113	Census Tract 96.07

Census Tracts Contained within the DWU Service Area

ID	County ID	Census Tract Name
133	113	Census Tract 96.08
134	113	Census Tract 96.09
135	113	Census Tract 96.11
136	113	Census Tract 97.02
137	113	Census Tract 92.02
138	113	Census Tract 93.01
139	113	Census Tract 93.04
140	121	Census Tract 208
141	121	Census Tract 204.01
142	121	Census Tract 202.02
143	121	Census Tract 203.03
144	121	Census Tract 214.03
145	121	Census Tract 216.15
146	121	Census Tract 203.05
147	121	Census Tract 204.02
148	121	Census Tract 204.03
149	121	Census Tract 206.02
150	121	Census Tract 207
151	121	Census Tract 209
152	121	Census Tract 210
153	121	Census Tract 211
154	121	Census Tract 213.01
155	121	Census Tract 215.02
156	121	Census Tract 215.05
157	121	Census Tract 214.09
158	113	Census Tract 84
159	113	Census Tract 85
160	113	Census Tract 86.04
161	113	Census Tract 87.01
162	113	Census Tract 87.04
163	113	Census Tract 88.01
164	113	Census Tract 98.02
165	113	Census Tract 91.04
166	439	Census Tract 1115.13
167	139	Census Tract 605
168	139	Census Tract 606
169	139	Census Tract 613
170	139	Census Tract 602.07
171	139	Census Tract 609
172	139	Census Tract 602.04
173	139	Census Tract 603
174	139	Census Tract 601.01
175	139	Census Tract 604
176	139	Census Tract 611

Census Tracts Contained within the DWU Service Area

ID	County ID	Census Tract Name
177	139	Census Tract 602.06
178	439	Census Tract 1139.06
179	439	Census Tract 1139.10
180	139	Census Tract 602.13
181	139	Census Tract 602.11
182	139	Census Tract 607.02
183	139	Census Tract 602.14
184	139	Census Tract 607.03
185	139	Census Tract 608.03
186	139	Census Tract 607.01
187	139	Census Tract 602.08
188	139	Census Tract 602.12
189	139	Census Tract 602.10
190	139	Census Tract 602.09
191	497	Census Tract 1501.01
192	497	Census Tract 1506.03
193	085	Census Tract 317.04
194	121	Census Tract 203.06
195	113	Census Tract 185.03
196	085	Census Tract 316.49
197	439	Census Tract 1115.38
198	113	Census Tract 190.16
199	439	Census Tract 1137.03
200	113	Census Tract 190.34
201	113	Census Tract 190.35
202	113	Census Tract 170.03
203	113	Census Tract 170.04
204	113	Census Tract 171.01
205	113	Census Tract 172.01
206	113	Census Tract 172.02
207	113	Census Tract 192.05
208	113	Census Tract 192.08
209	113	Census Tract 173.01
210	113	Census Tract 173.06
211	113	Census Tract 193.01
212	113	Census Tract 195.01
213	113	Census Tract 195.02
214	113	Census Tract 196
215	113	Census Tract 197
216	113	Census Tract 198
217	113	Census Tract 199
218	113	Census Tract 136.07
219	113	Census Tract 159
220	113	Census Tract 126.04

Census Tracts Contained within the DWU Service Area

ID	County ID	Census Tract Name
221	113	Census Tract 130.10
222	113	Census Tract 136.22
223	113	Census Tract 136.21
224	113	Census Tract 136.23
225	113	Census Tract 141.35
226	113	Census Tract 141.34
227	113	Census Tract 141.33
228	113	Census Tract 141.36
229	113	Census Tract 141.29
230	113	Census Tract 143.11
231	113	Census Tract 165.23
232	113	Census Tract 166.25
233	113	Census Tract 166.26
234	113	Census Tract 166.21
235	113	Census Tract 166.23
236	113	Census Tract 192.13
237	113	Census Tract 137.26
238	113	Census Tract 166.24
239	113	Census Tract 166.22
240	113	Census Tract 79.11
241	113	Census Tract 109.03
242	113	Census Tract 17.03
243	113	Census Tract 192.12
244	113	Census Tract 203
245	113	Census Tract 205
246	113	Census Tract 206
247	113	Census Tract 207
248	113	Census Tract 141.27
249	113	Census Tract 123.01
250	113	Census Tract 123.02
251	085	Census Tract 317.13
252	085	Census Tract 303.05
253	085	Census Tract 317.11
254	439	Census Tract 1137.05
255	085	Census Tract 317.12
256	085	Census Tract 317.14
257	085	Census Tract 317.16
258	085	Census Tract 317.15
259	085	Census Tract 317.20
260	085	Census Tract 317.19
261	113	Census Tract 17.04
262	113	Census Tract 136.26
263	113	Census Tract 108.03
264	113	Census Tract 109.02

Census Tracts Contained within the DWU Service Area

ID	County ID	Census Tract Name
265	439	Census Tract 1130.02
266	113	Census Tract 110.02
267	113	Census Tract 111.01
268	113	Census Tract 111.03
269	113	Census Tract 111.04
270	113	Census Tract 101.01
271	113	Census Tract 101.02
272	113	Census Tract 105
273	113	Census Tract 106.01
274	113	Census Tract 106.02
275	113	Census Tract 201
276	113	Census Tract 202
277	113	Census Tract 141.28
278	113	Census Tract 165.22
279	113	Census Tract 6.06
280	121	Census Tract 202.04
281	121	Census Tract 202.05
282	121	Census Tract 201.15
283	121	Census Tract 214.05
284	121	Census Tract 215.15
285	121	Census Tract 215.27
286	121	Census Tract 201.14
287	121	Census Tract 205.06
288	121	Census Tract 205.04
289	121	Census Tract 203.08
290	121	Census Tract 213.04
291	121	Census Tract 217.18
292	121	Census Tract 215.13
293	121	Census Tract 216.19
294	121	Census Tract 217.20
295	121	Census Tract 216.23
296	121	Census Tract 216.25
297	121	Census Tract 216.22
298	113	Census Tract 168.03
299	113	Census Tract 78.12
300	113	Census Tract 98.03
301	113	Census Tract 137.17
302	113	Census Tract 61
303	113	Census Tract 31.01
304	121	Census Tract 216.36
305	113	Census Tract 34
306	113	Census Tract 78.09
307	113	Census Tract 136.18
308	113	Census Tract 99

Census Tracts Contained within the DWU Service Area

ID	County ID	Census Tract Name
309	113	Census Tract 98.04
310	113	Census Tract 165.16
311	113	Census Tract 92.01
312	113	Census Tract 91.03
313	113	Census Tract 100
314	113	Census Tract 15.04
315	113	Census Tract 143.08
316	113	Census Tract 67
317	113	Census Tract 68
318	113	Census Tract 69
319	113	Census Tract 97.01
320	113	Census Tract 137.12
321	113	Census Tract 146.03
322	113	Census Tract 166.18
323	113	Census Tract 166.19
324	113	Census Tract 167.03
325	113	Census Tract 1
326	113	Census Tract 2.01
327	113	Census Tract 2.02
328	113	Census Tract 3
329	113	Census Tract 4.01
330	113	Census Tract 4.04
331	113	Census Tract 5
332	113	Census Tract 6.01
333	113	Census Tract 6.03
334	113	Census Tract 7.01
335	113	Census Tract 7.02
336	113	Census Tract 8
337	113	Census Tract 9
338	113	Census Tract 4.05
339	113	Census Tract 10.01
340	113	Census Tract 10.02
341	113	Census Tract 11.02
342	113	Census Tract 12.04
343	113	Census Tract 13.01
344	113	Census Tract 13.02
345	113	Census Tract 14
346	113	Census Tract 11.01
347	113	Census Tract 15.02
348	113	Census Tract 15.03
349	113	Census Tract 16
350	113	Census Tract 17.01
351	113	Census Tract 122.09
352	113	Census Tract 166.20

Census Tracts Contained within the DWU Service Area

ID	County ID	Census Tract Name
353	113	Census Tract 167.01
354	113	Census Tract 162.02
355	113	Census Tract 164.09
356	113	Census Tract 110.01
357	113	Census Tract 93.03
358	113	Census Tract 86.03
359	113	Census Tract 169.02
360	113	Census Tract 116.01
361	113	Census Tract 90
362	113	Census Tract 193.02
363	113	Census Tract 146.01
364	113	Census Tract 46
365	113	Census Tract 71.02
366	113	Census Tract 78.20
367	113	Census Tract 72.01
368	113	Census Tract 72.02
369	113	Census Tract 73.01
370	113	Census Tract 73.02
371	113	Census Tract 37
372	113	Census Tract 78.10
373	113	Census Tract 79.03
374	113	Census Tract 79.06
375	113	Census Tract 38
376	113	Census Tract 39.01
377	113	Census Tract 168.02
378	113	Census Tract 167.04
379	113	Census Tract 167.05
380	113	Census Tract 87.05
381	113	Census Tract 107.01
382	113	Census Tract 139.01
383	113	Census Tract 39.02
384	113	Census Tract 40
385	113	Census Tract 41
386	113	Census Tract 42.02
387	113	Census Tract 43
388	113	Census Tract 44
389	113	Census Tract 45
390	121	Census Tract 219
391	121	Census Tract 215.22
392	121	Census Tract 205.05
393	121	Census Tract 217.46
394	121	Census Tract 217.19
395	121	Census Tract 217.47
396	121	Census Tract 213.05

Census Tracts Contained within the DWU Service Area

ID	County ID	Census Tract Name
397	121	Census Tract 212.02
398	121	Census Tract 214.08
399	121	Census Tract 213.03
400	121	Census Tract 216.18
401	121	Census Tract 215.17
402	121	Census Tract 217.45
403	121	Census Tract 217.44
404	121	Census Tract 217.16
405	121	Census Tract 215.14
406	121	Census Tract 217.17
407	121	Census Tract 217.15
408	121	Census Tract 217.21
409	121	Census Tract 215.16
410	121	Census Tract 215.18
411	121	Census Tract 215.19
412	121	Census Tract 216.29
413	121	Census Tract 216.21
414	121	Census Tract 215.21
415	121	Census Tract 217.23
416	121	Census Tract 217.30
417	121	Census Tract 217.40
418	085	Census Tract 317.17
419	121	Census Tract 216.30
420	113	Census Tract 136.15
421	113	Census Tract 136.17
422	113	Census Tract 136.19
423	439	Census Tract 1139.07
424	121	Census Tract 217.39
425	121	Census Tract 216.33
426	121	Census Tract 216.28
427	121	Census Tract 216.32
428	121	Census Tract 216.35
429	121	Census Tract 216.34
430	113	Census Tract 137.14
431	113	Census Tract 137.15
432	113	Census Tract 137.16
433	113	Census Tract 137.18
434	113	Census Tract 137.19
435	113	Census Tract 137.20
436	121	Census Tract 216.38
437	439	Census Tract 1113.10
438	439	Census Tract 1115.47
439	439	Census Tract 1219.04
440	113	Census Tract 137.21

Census Tracts Contained within the DWU Service Area

ID	County ID	Census Tract Name
441	113	Census Tract 137.22
442	113	Census Tract 137.25
443	085	Census Tract 317.06
444	121	Census Tract 216.20
445	121	Census Tract 201.06
446	121	Census Tract 215.25
447	121	Census Tract 214.04
448	121	Census Tract 203.09
449	121	Census Tract 203.07
450	121	Census Tract 217.50
451	121	Census Tract 216.24
452	121	Census Tract 217.42
453	121	Census Tract 201.11
454	121	Census Tract 202.03
455	121	Census Tract 201.03
456	121	Census Tract 201.07
457	121	Census Tract 216.37
458	121	Census Tract 217.43
459	121	Census Tract 217.27
460	439	Census Tract 1136.31
461	439	Census Tract 1137.11
462	113	Census Tract 138.03
463	113	Census Tract 138.04
464	113	Census Tract 139.02
465	113	Census Tract 140.01
466	113	Census Tract 141.03
467	085	Census Tract 317.08
468	113	Census Tract 190.40
469	113	Census Tract 185.06
470	113	Census Tract 109.04
471	113	Census Tract 141.32
472	121	Census Tract 201.10
473	121	Census Tract 216.26
474	121	Census Tract 217.37
475	121	Census Tract 217.38
476	121	Census Tract 217.35
477	439	Census Tract 1131.16
478	121	Census Tract 216.31
479	113	Census Tract 141.13
480	113	Census Tract 141.15
481	113	Census Tract 141.16
482	085	Census Tract 317.09
483	439	Census Tract 1137.07
484	439	Census Tract 1115.36

Census Tracts Contained within the DWU Service Area

ID	County ID	Census Tract Name
485	439	Census Tract 1139.27
486	121	Census Tract 217.33
487	121	Census Tract 217.34
488	121	Census Tract 217.32
489	121	Census Tract 217.31
490	121	Census Tract 217.29
491	121	Census Tract 217.26
492	439	Census Tract 1135.20
493	113	Census Tract 141.19
494	113	Census Tract 141.20
495	113	Census Tract 141.23
496	113	Census Tract 141.26
497	439	Census Tract 1131.13
498	439	Census Tract 1136.34
499	121	Census Tract 201.12
500	121	Census Tract 205.03
501	121	Census Tract 212.01
502	121	Census Tract 214.07
503	121	Census Tract 217.25
504	439	Census Tract 1136.32
505	439	Census Tract 1137.10
506	439	Census Tract 1219.03
507	439	Census Tract 1131.14
508	439	Census Tract 1135.18
509	439	Census Tract 1137.09
510	113	Census Tract 142.03
511	113	Census Tract 142.04
512	113	Census Tract 143.02
513	113	Census Tract 143.06
514	113	Census Tract 143.07
515	439	Census Tract 1115.39
516	121	Census Tract 217.22
517	085	Census Tract 318.04
518	121	Census Tract 217.49
519	121	Census Tract 217.51
520	121	Census Tract 217.52
521	121	Census Tract 215.20
522	121	Census Tract 218
523	113	Census Tract 125
524	113	Census Tract 126.01
525	113	Census Tract 127.01
526	113	Census Tract 127.02
527	113	Census Tract 128
528	113	Census Tract 129

Census Tracts Contained within the DWU Service Area

ID	County ID	Census Tract Name
529	113	Census Tract 143.10
530	113	Census Tract 144.03
531	113	Census Tract 144.05
532	113	Census Tract 144.06
533	113	Census Tract 144.07
534	113	Census Tract 144.08
535	113	Census Tract 143.09
536	113	Census Tract 136.20
537	113	Census Tract 64.02
538	439	Census Tract 1065.18
539	113	Census Tract 108.04
540	113	Census Tract 108.05
541	113	Census Tract 64.01
542	113	Census Tract 131.05
543	113	Census Tract 131.04
544	113	Census Tract 78.23
545	113	Census Tract 78.22
546	113	Census Tract 78.21
547	113	Census Tract 130.11
548	113	Census Tract 78.27
549	113	Census Tract 130.04
550	113	Census Tract 130.05
551	113	Census Tract 130.07
552	113	Census Tract 130.08
553	113	Census Tract 130.09
554	113	Census Tract 131.01
555	113	Census Tract 78.26
556	113	Census Tract 78.24
557	113	Census Tract 78.25
558	113	Census Tract 131.02
559	113	Census Tract 145.01
560	113	Census Tract 145.02
561	113	Census Tract 146.02
562	113	Census Tract 147.01
563	113	Census Tract 147.02
564	113	Census Tract 149.01
565	113	Census Tract 149.02
566	113	Census Tract 79.10
567	113	Census Tract 79.09
568	113	Census Tract 138.06
569	113	Census Tract 137.27
570	113	Census Tract 142.05
571	113	Census Tract 143.12
572	113	Census Tract 141.37

Census Tracts Contained within the DWU Service Area

ID	County ID	Census Tract Name
573	113	Census Tract 164.12
574	113	Census Tract 164.13
575	113	Census Tract 132
576	113	Census Tract 133
577	113	Census Tract 134
578	113	Census Tract 135
579	113	Census Tract 136.05
580	113	Census Tract 136.06
581	113	Census Tract 136.08
582	113	Census Tract 150
583	113	Census Tract 151
584	113	Census Tract 152.02
585	113	Census Tract 152.04
586	113	Census Tract 152.05
587	113	Census Tract 152.06
588	113	Census Tract 153.03
589	113	Census Tract 153.05
590	439	Census Tract 1130.01
591	113	Census Tract 91.01
592	439	Census Tract 1115.37
593	113	Census Tract 94.01
594	113	Census Tract 94.02
595	113	Census Tract 95
596	439	Census Tract 1136.10
597	439	Census Tract 1139.09
598	439	Census Tract 1141.03
599	439	Census Tract 1135.19
600	439	Census Tract 1139.26
601	439	Census Tract 9800
602	439	Census Tract 1115.48
603	439	Census Tract 1136.33
604	439	Census Tract 1115.49
605	439	Census Tract 1113.14
606	439	Census Tract 1113.13
607	113	Census Tract 126.03
608	113	Census Tract 204
609	085	Census Tract 317.18
610	113	Census Tract 4.06
611	113	Census Tract 165.20
612	113	Census Tract 142.06
613	113	Census Tract 141.38
614	113	Census Tract 141.30
615	113	Census Tract 79.12
616	113	Census Tract 138.05

Census Tracts Contained within the DWU Service Area

ID	County ID	Census Tract Name
617	113	Census Tract 165.21
618	113	Census Tract 185.05
619	113	Census Tract 141.31
620	113	Census Tract 9800
621	113	Census Tract 79.13
622	113	Census Tract 200
623	121	Census Tract 215.24
624	121	Census Tract 217.41
625	121	Census Tract 217.24
626	121	Census Tract 217.53
627	121	Census Tract 201.04
628	121	Census Tract 201.08
629	121	Census Tract 201.13
630	121	Census Tract 201.05
631	121	Census Tract 217.36
632	121	Census Tract 214.06
633	121	Census Tract 203.10
634	121	Census Tract 217.48
635	121	Census Tract 215.12
636	121	Census Tract 201.09
637	121	Census Tract 215.26
638	113	Census Tract 136.16
639	113	Census Tract 190.18
640	113	Census Tract 157
641	113	Census Tract 160.01
642	113	Census Tract 160.02
643	113	Census Tract 161
644	113	Census Tract 162.01
645	257	Census Tract 508
646	113	Census Tract 163.01
647	113	Census Tract 164.01
648	113	Census Tract 164.08
649	113	Census Tract 164.10
650	113	Census Tract 164.11
651	113	Census Tract 165.02
652	113	Census Tract 163.02
653	113	Census Tract 165.09
654	113	Census Tract 165.10
655	113	Census Tract 165.11
656	113	Census Tract 166.15
657	113	Census Tract 166.16

Census Tracts Contained within the TRWD Service Area

ID	County ID	Census Tract Name
1	439	Census Tract 1138.09
2	439	Census Tract 1216.09
3	251	Census Tract 1302.13
4	251	Census Tract 1302.12
5	251	Census Tract 1302.10
6	251	Census Tract 1303.04
7	251	Census Tract 1302.11
8	251	Census Tract 1303.03
9	251	Census Tract 1302.14
10	251	Census Tract 1304.07
11	439	Census Tract 1028
12	439	Census Tract 1115.22
13	439	Census Tract 1024.01
14	439	Census Tract 1131.09
15	367	Census Tract 1407.06
16	367	Census Tract 1404.08
17	367	Census Tract 1401.02
18	367	Census Tract 1404.09
19	367	Census Tract 1407.03
20	367	Census Tract 1401.01
21	439	Census Tract 1136.11
22	113	Census Tract 154.01
23	113	Census Tract 154.03
24	113	Census Tract 154.04
25	251	Census Tract 1302.05
26	251	Census Tract 1302.08
27	251	Census Tract 1304.09
28	439	Census Tract 1107.03
29	439	Census Tract 1136.28
30	439	Census Tract 1136.29
31	113	Census Tract 170.01
32	113	Census Tract 169.03
33	439	Census Tract 1037.01
34	439	Census Tract 1038
35	439	Census Tract 1037.02
36	257	Census Tract 512.02
37	257	Census Tract 512.01
38	439	Census Tract 1035
39	439	Census Tract 1046.02
40	439	Census Tract 1046.04
41	439	Census Tract 1041
42	439	Census Tract 1042.01
43	439	Census Tract 1042.02
44	439	Census Tract 1043

Census Tracts Contained within the TRWD Service Area

ID	County ID	Census Tract Name
45	439	Census Tract 1044
46	439	Census Tract 1045.04
47	439	Census Tract 1045.05
48	439	Census Tract 1046.01
49	439	Census Tract 1115.16
50	439	Census Tract 1046.03
51	439	Census Tract 1139.16
52	439	Census Tract 1115.05
53	439	Census Tract 1115.21
54	439	Census Tract 1142.05
55	439	Census Tract 1138.10
56	439	Census Tract 1022.01
57	439	Census Tract 1135.14
58	121	Census Tract 202.02
59	121	Census Tract 203.05
60	439	Census Tract 1065.11
61	439	Census Tract 1065.12
62	439	Census Tract 1065.13
63	439	Census Tract 1065.14
64	439	Census Tract 1065.15
65	439	Census Tract 1065.16
66	439	Census Tract 1066
67	439	Census Tract 1114.04
68	439	Census Tract 1046.05
69	439	Census Tract 1048.02
70	439	Census Tract 1050.01
71	439	Census Tract 1110.13
72	439	Census Tract 1050.06
73	439	Census Tract 1052.01
74	439	Census Tract 1052.04
75	439	Census Tract 1052.05
76	439	Census Tract 1054.03
77	439	Census Tract 1054.04
78	439	Census Tract 1054.05
79	439	Census Tract 1054.06
80	439	Census Tract 1055.02
81	439	Census Tract 1115.06
82	439	Census Tract 1115.13
83	439	Census Tract 1115.14
84	439	Census Tract 1055.03
85	439	Census Tract 1055.05
86	439	Census Tract 1055.08
87	439	Census Tract 1055.10
88	439	Census Tract 1055.11

Census Tracts Contained within the TRWD Service Area

ID	County ID	Census Tract Name
89	439	Census Tract 1055.12
90	439	Census Tract 1056
91	439	Census Tract 1057.01
92	439	Census Tract 1057.03
93	439	Census Tract 1057.04
94	439	Census Tract 1058
95	439	Census Tract 1111.02
96	439	Census Tract 1112.02
97	439	Census Tract 1113.04
98	439	Census Tract 1060.01
99	439	Census Tract 1060.02
100	439	Census Tract 1061.01
101	439	Census Tract 1061.02
102	439	Census Tract 1062.01
103	439	Census Tract 1062.02
104	439	Census Tract 1063
105	439	Census Tract 1065.02
106	439	Census Tract 1065.03
107	439	Census Tract 1065.07
108	439	Census Tract 1065.10
109	139	Census Tract 605
110	139	Census Tract 606
111	139	Census Tract 614
112	139	Census Tract 613
113	139	Census Tract 602.07
114	139	Census Tract 615
115	139	Census Tract 616
116	139	Census Tract 617
117	139	Census Tract 609
118	139	Census Tract 602.04
119	139	Census Tract 610
120	139	Census Tract 603
121	139	Census Tract 601.01
122	139	Census Tract 604
123	139	Census Tract 612
124	139	Census Tract 611
125	139	Census Tract 601.02
126	139	Census Tract 602.06
127	251	Census Tract 1302.15
128	349	Census Tract 9709
129	349	Census Tract 9702
130	349	Census Tract 9703
131	349	Census Tract 9708
132	349	Census Tract 9707

Census Tracts Contained within the TRWD Service Area

ID	County ID	Census Tract Name
133	349	Census Tract 9705
134	349	Census Tract 9706
135	349	Census Tract 9701
136	349	Census Tract 9704
137	349	Census Tract 9710
138	439	Census Tract 1139.06
139	439	Census Tract 1139.10
140	439	Census Tract 1140.03
141	439	Census Tract 1222
142	439	Census Tract 1223
143	439	Census Tract 1224
144	439	Census Tract 1225
145	213	Census Tract 9504
146	213	Census Tract 9510
147	213	Census Tract 9511
148	213	Census Tract 9508
149	213	Census Tract 9507
150	213	Census Tract 9505
151	213	Census Tract 9513
152	213	Census Tract 9503
153	213	Census Tract 9512
154	439	Census Tract 1226
155	439	Census Tract 1140.05
156	439	Census Tract 1216.01
157	439	Census Tract 1216.04
158	439	Census Tract 1140.06
159	139	Census Tract 602.13
160	139	Census Tract 602.11
161	139	Census Tract 608.01
162	139	Census Tract 607.02
163	139	Census Tract 602.14
164	139	Census Tract 607.03
165	139	Census Tract 608.02
166	139	Census Tract 608.03
167	139	Census Tract 607.01
168	139	Census Tract 602.08
169	139	Census Tract 602.12
170	139	Census Tract 602.10
171	139	Census Tract 602.09
172	497	Census Tract 1501.01
173	497	Census Tract 1504.02
174	497	Census Tract 1503
175	497	Census Tract 1506.01
176	497	Census Tract 1502

Census Tracts Contained within the TRWD Service Area

ID	County ID	Census Tract Name
177	497	Census Tract 1506.03
178	497	Census Tract 1504.01
179	497	Census Tract 1505
180	497	Census Tract 1506.02
181	497	Census Tract 1501.02
182	497	Census Tract 1504.03
183	121	Census Tract 203.06
184	439	Census Tract 1114.02
185	439	Census Tract 1115.31
186	439	Census Tract 1115.32
187	439	Census Tract 1115.33
188	439	Census Tract 1115.34
189	439	Census Tract 1115.38
190	439	Census Tract 1138.03
191	439	Census Tract 1138.08
192	439	Census Tract 1115.45
193	439	Census Tract 1115.46
194	439	Census Tract 1131.02
195	439	Census Tract 1131.04
196	439	Census Tract 1131.07
197	439	Census Tract 1132.12
198	439	Census Tract 1132.13
199	439	Census Tract 1132.14
200	439	Census Tract 1132.15
201	439	Census Tract 1132.16
202	439	Census Tract 1132.17
203	439	Census Tract 1136.24
204	439	Census Tract 1136.25
205	439	Census Tract 1136.26
206	439	Census Tract 1136.27
207	439	Census Tract 1136.30
208	439	Census Tract 1137.03
209	439	Census Tract 1136.23
210	439	Census Tract 1229
211	439	Census Tract 1107.04
212	113	Census Tract 165.23
213	113	Census Tract 166.23
214	113	Census Tract 166.22
215	251	Census Tract 1305
216	251	Census Tract 1301
217	251	Census Tract 1302.07
218	251	Census Tract 1302.04
219	251	Census Tract 1304.05
220	251	Census Tract 1304.08

Census Tracts Contained within the TRWD Service Area

ID	County ID	Census Tract Name
221	251	Census Tract 1304.06
222	251	Census Tract 1304.10
223	439	Census Tract 1001.01
224	439	Census Tract 1137.05
225	439	Census Tract 1065.09
226	439	Census Tract 1109.06
227	439	Census Tract 1134.03
228	439	Census Tract 1142.04
229	439	Census Tract 1027
230	439	Census Tract 1138.11
231	439	Census Tract 1217.04
232	439	Census Tract 1130.02
233	439	Census Tract 1064
234	439	Census Tract 1060.04
235	439	Census Tract 1036.02
236	367	Census Tract 1404.07
237	367	Census Tract 1404.05
238	367	Census Tract 1402
239	367	Census Tract 1403
240	367	Census Tract 1404.03
241	121	Census Tract 202.04
242	121	Census Tract 203.08
243	439	Census Tract 1109.01
244	439	Census Tract 1109.03
245	367	Census Tract 1405.02
246	367	Census Tract 1404.11
247	367	Census Tract 1405.01
248	367	Census Tract 1404.10
249	367	Census Tract 1407.04
250	367	Census Tract 1407.05
251	113	Census Tract 168.02
252	439	Census Tract 1135.16
253	439	Census Tract 1136.07
254	439	Census Tract 1136.12
255	439	Census Tract 1136.13
256	237	Census Tract 9505
257	439	Census Tract 1136.18
258	213	Census Tract 9509.01
259	213	Census Tract 9506.02
260	213	Census Tract 9509.02
261	213	Census Tract 9509.03
262	213	Census Tract 9506.01
263	439	Census Tract 1136.19
264	439	Census Tract 1023.01

Census Tracts Contained within the TRWD Service Area

ID	County ID	Census Tract Name
265	439	Census Tract 1023.02
266	439	Census Tract 1024.02
267	439	Census Tract 1025
268	439	Census Tract 1008
269	439	Census Tract 1009
270	439	Census Tract 1012.01
271	439	Census Tract 1012.02
272	439	Census Tract 1013.01
273	439	Census Tract 1014.01
274	439	Census Tract 1014.03
275	439	Census Tract 1015
276	439	Census Tract 1017
277	439	Census Tract 1014.02
278	439	Census Tract 1136.22
279	439	Census Tract 1001.02
280	439	Census Tract 1002.01
281	439	Census Tract 1002.02
282	439	Census Tract 1003
283	439	Census Tract 1004
284	439	Census Tract 1005.01
285	439	Census Tract 1005.02
286	439	Census Tract 1020
287	439	Census Tract 1021
288	439	Census Tract 1022.02
289	439	Census Tract 1110.05
290	439	Census Tract 1110.03
291	439	Census Tract 1110.08
292	439	Census Tract 1139.07
293	439	Census Tract 1131.10
294	439	Census Tract 1006.02
295	439	Census Tract 1113.12
296	439	Census Tract 1113.07
297	439	Census Tract 1114.06
298	439	Census Tract 1113.10
299	439	Census Tract 1115.47
300	439	Census Tract 1235
301	439	Census Tract 1234
302	439	Census Tract 1113.08
303	439	Census Tract 1219.04
304	439	Census Tract 1115.53
305	439	Census Tract 1228.01
306	439	Census Tract 1115.52
307	439	Census Tract 1220.01
308	439	Census Tract 1220.02

Census Tracts Contained within the TRWD Service Area

ID	County ID	Census Tract Name
309	439	Census Tract 1131.15
310	439	Census Tract 1142.06
311	439	Census Tract 1138.12
312	439	Census Tract 1139.21
313	121	Census Tract 203.09
314	121	Census Tract 203.07
315	439	Census Tract 1139.28
316	439	Census Tract 1139.23
317	439	Census Tract 1110.16
318	439	Census Tract 1110.15
319	439	Census Tract 1228.02
320	439	Census Tract 1136.31
321	439	Census Tract 1137.11
322	439	Census Tract 1139.22
323	439	Census Tract 1233
324	439	Census Tract 1142.07
325	439	Census Tract 1111.04
326	439	Census Tract 1219.05
327	439	Census Tract 1131.16
328	439	Census Tract 1108.09
329	439	Census Tract 1231
330	439	Census Tract 1013.02
331	439	Census Tract 1106
332	439	Census Tract 1108.06
333	439	Census Tract 1111.03
334	439	Census Tract 1137.07
335	439	Census Tract 1107.01
336	439	Census Tract 1115.36
337	439	Census Tract 1216.06
338	439	Census Tract 1139.11
339	439	Census Tract 1142.03
340	439	Census Tract 1049
341	161	Census Tract 3
342	161	Census Tract 2
343	161	Census Tract 1
344	161	Census Tract 7
345	161	Census Tract 6
346	161	Census Tract 4
347	439	Census Tract 1138.13
348	439	Census Tract 1026.02
349	439	Census Tract 1026.01
350	439	Census Tract 1139.27
351	439	Census Tract 1048.04
352	439	Census Tract 1139.19

Census Tracts Contained within the TRWD Service Area

ID	County ID	Census Tract Name
353	439	Census Tract 1139.24
354	439	Census Tract 1139.25
355	439	Census Tract 1132.20
356	439	Census Tract 1132.21
357	439	Census Tract 1135.20
358	439	Census Tract 1048.03
359	439	Census Tract 1047.02
360	113	Census Tract 141.26
361	439	Census Tract 1059.02
362	439	Census Tract 1050.08
363	439	Census Tract 1050.07
364	439	Census Tract 1055.14
365	439	Census Tract 1055.13
366	439	Census Tract 1131.13
367	439	Census Tract 1136.34
368	439	Census Tract 1110.18
369	439	Census Tract 1112.04
370	439	Census Tract 1065.17
371	439	Census Tract 1115.23
372	439	Census Tract 1115.24
373	439	Census Tract 1115.25
374	439	Census Tract 1115.26
375	439	Census Tract 1115.29
376	439	Census Tract 1115.30
377	439	Census Tract 1136.32
378	439	Census Tract 1137.10
379	439	Census Tract 1047.01
380	439	Census Tract 1139.18
381	439	Census Tract 1110.17
382	439	Census Tract 1219.03
383	439	Census Tract 1131.14
384	439	Census Tract 1135.17
385	439	Census Tract 1135.18
386	439	Census Tract 1137.09
387	439	Census Tract 1139.17
388	439	Census Tract 1113.09
389	439	Census Tract 1059.01
390	439	Census Tract 1232
391	439	Census Tract 1230
392	439	Census Tract 1236
393	439	Census Tract 1115.39
394	439	Census Tract 1115.40
395	439	Census Tract 1115.41
396	439	Census Tract 1115.42

Census Tracts Contained within the TRWD Service Area

ID	County ID	Census Tract Name
397	439	Census Tract 1108.05
398	439	Census Tract 1115.43
399	439	Census Tract 1115.44
400	439	Census Tract 1115.50
401	439	Census Tract 1114.08
402	439	Census Tract 1115.51
403	439	Census Tract 1113.11
404	439	Census Tract 1131.08
405	439	Census Tract 1131.11
406	439	Census Tract 1131.12
407	439	Census Tract 1132.06
408	439	Census Tract 1132.07
409	439	Census Tract 1108.07
410	113	Census Tract 144.03
411	439	Census Tract 1132.18
412	439	Census Tract 1133.01
413	439	Census Tract 1133.02
414	439	Census Tract 1134.05
415	439	Census Tract 1134.07
416	439	Census Tract 1134.08
417	439	Census Tract 1065.18
418	439	Census Tract 1139.29
419	439	Census Tract 1135.09
420	439	Census Tract 1135.10
421	439	Census Tract 1135.11
422	439	Census Tract 1135.12
423	439	Census Tract 1135.13
424	113	Census Tract 153.03
425	439	Census Tract 1055.07
426	439	Census Tract 1109.07
427	439	Census Tract 1139.12
428	439	Census Tract 1110.11
429	439	Census Tract 1130.01
430	439	Census Tract 1109.05
431	439	Census Tract 1216.10
432	439	Census Tract 1114.05
433	439	Census Tract 1006.01
434	439	Census Tract 1139.08
435	439	Census Tract 1007
436	439	Census Tract 1045.02
437	439	Census Tract 1113.06
438	439	Census Tract 1115.37
439	439	Census Tract 1132.10
440	439	Census Tract 1110.10

Census Tracts Contained within the TRWD Service Area

ID	County ID	Census Tract Name
441	439	Census Tract 1113.01
442	439	Census Tract 1110.12
443	439	Census Tract 1052.03
444	439	Census Tract 1136.10
445	439	Census Tract 1139.09
446	439	Census Tract 1102.04
447	439	Census Tract 1103.01
448	439	Census Tract 1103.02
449	439	Census Tract 1104.02
450	439	Census Tract 1105
451	439	Census Tract 1141.04
452	439	Census Tract 1141.03
453	439	Census Tract 1138.16
454	439	Census Tract 1138.15
455	439	Census Tract 1108.08
456	439	Census Tract 1135.19
457	439	Census Tract 1140.08
458	439	Census Tract 1139.26
459	439	Census Tract 9800
460	439	Census Tract 1139.20
461	439	Census Tract 1114.07
462	439	Census Tract 1114.09
463	439	Census Tract 1115.48
464	439	Census Tract 1219.06
465	439	Census Tract 1138.14
466	439	Census Tract 1136.33
467	439	Census Tract 1140.07
468	439	Census Tract 1112.03
469	439	Census Tract 1115.49
470	439	Census Tract 1113.14
471	439	Census Tract 1113.13
472	113	Census Tract 9800
473	113	Census Tract 200
474	439	Census Tract 1067
475	439	Census Tract 1101.01
476	439	Census Tract 1101.02
477	439	Census Tract 1102.03
478	237	Census Tract 9503
479	237	Census Tract 9501
480	439	Census Tract 1216.05
481	439	Census Tract 1216.08
482	439	Census Tract 1216.11
483	439	Census Tract 1217.02
484	439	Census Tract 1217.03

Census Tracts Contained within the TRWD Service Area

ID	County ID	Census Tract Name
485	439	Census Tract 1036.01
486	439	Census Tract 1141.02
487	439	Census Tract 1104.01
488	439	Census Tract 1134.04
489	439	Census Tract 1221
490	439	Census Tract 1227
491	439	Census Tract 1045.03
492	439	Census Tract 1102.02
493	113	Census Tract 161
494	257	Census Tract 513
495	257	Census Tract 508
496	113	Census Tract 164.01
497	113	Census Tract 164.10
498	113	Census Tract 164.11
499	113	Census Tract 166.16

Projected Population for Customers of Dallas

WUGs	2011 Population Revisions Applied to DWU					
	2010	2020	2030	2040	2050	2060
Addison	16,000	20,534	22,358	23,629	24,515	25,133
Carrollton	121,000	124,000	128,500	131,320	133,450	134,800
Hebron	500	500	500	500	500	500
Cedar Hill	45,006	65,460	76,836	80,316	80,316	80,316
Cockrell Hill	4,782	4,947	5,028	5,067	5,086	5,095
Coppell	40,415	40,577	40,715	40,832	40,932	41,016
Dallas	1,312,324	1,415,000	1,495,000	1,598,223	1,764,681	2,058,767
Balch Springs	21,083	22,564	23,849	24,963	25,930	26,768
Dallas County - Other	737	572	444	339	267	201
Denton	0	0	34,265	89,385	156,342	288,625
DeSoto	47,649	57,243	65,849	73,881	82,923	85,400
Duncanville	37,100	37,100	37,100	37,100	37,100	37,100
Farmers Branch	30,470	33,161	35,608	37,833	39,855	41,693
Flower Mound	33,334	34,000	35,712	35,712	35,712	35,712
Glenn Heights	11,423	13,833	16,516	19,102	21,705	24,332
Oak Leaf	1,257	1,526	1,791	2,064	2,368	2,705
Grand Prairie	138,890	79,184	109,037	135,988	164,725	164,725
Grapevine	11,503	10,725	10,680	9,600	8,820	8,220
Hutchins	3,200	4,000	5,000	6,500	8,500	14,000
Wilmer	1,037	1,712	2,465	4,740	11,242	19,228
Irving	59,413	67,228	14,584	14,459	14,390	14,460
Lancaster	37,392	59,067	64,648	64,648	64,648	64,648
Lewisville	97,709	110,002	122,002	136,002	155,002	176,515
Denton County FWSD NO. 1A	309	1,634	2,211	2,805	3,408	4,039
Ovilla	3,634	5,851	8,066	10,287	10,829	11,621
Red Oak	10,000	17,850	23,400	26,600	28,500	30,400
Seagoville	13,017	16,327	19,537	22,848	25,536	27,517
Combine WSC	4,122	5,737	7,202	8,795	10,785	13,285
Combine	2,393	2,969	3,474	4,019	4,702	5,563
The Colony	36,450	50,400	56,700	58,500	60,300	60,840
UTRWD	72,061	287,544	322,273	331,711	339,917	346,339
UTRWD Add'l						63,290
Total	**2,214,210**	**2,591,247**	**2,791,350**	**3,037,768**	**3,362,986**	**3,912,853**

Projected Population for Customers of Tarrant Regional Water District

WUGs	2011 Population Revisions Applied to TRWD					
	2010	2020	2030	2040	2050	2060
Arlington	331,146	373,575	398,700	421,082	421,554	422,498
Grand Prairie (through Arlington)	0	44,799	44,799	44,799	44,799	44,799
Bethesda WSC	0	10,551	13,196	16,069	19,598	23,900
Azle	12,108	16,795	23,473	31,060	38,682	45,362
Benbrook	18,912	27,000	30,000	36,000	43,000	51,000
Blue Mound	0	0	0	0	0	0
Bridgeport	5,900	8,352	12,001	14,296	16,657	19,936
Community WSC	3,536	3,588	3,642	3,699	3,767	3,847
Decatur	6,804	8,508	11,738	15,253	19,751	23,225
East Cedar Creek FWSD	9,973	11,178	13,363	14,568	15,773	16,978
Gun Barrel City	3,066	4,321	4,954	5,603	6,395	7,394
Fort Worth	732,201	926,822	1,127,326	1,379,008	1,696,962	2,085,879
Aledo	0	2,675	6,138	9,616	10,262	10,262
Bethesda WSC	24,111	21,117	26,383	32,129	39,172	47,768
Burleson	32,091	48,255	60,336	61,782	63,517	65,567
Crowley	8,190	10,549	14,181	20,246	25,128	27,589
Dalworthington Gardens	1,616	1,786	1,901	1,969	2,020	2,052
Denton County-Other	2,137	2,822	3,271	3,686	4,090	4,506
Edgecliff	2,550	2,550	2,550	2,550	2,550	2,550
Everman	1,922	2,198	2,072	1,940	1,901	1,901
Forest Hill	12,000	13,090	14,210	15,392	16,738	17,574
Grand Prairie	6,460	89,180	90,787	91,265	90,642	90,642
Haltom City	41,000	50,322	53,058	54,428	55,113	55,456
Haslet	1,692	3,688	6,685	6,685	6,685	6,685
Hurst	34,635	36,695	36,654	36,572	36,531	36,531
Keller	40,127	45,026	51,310	51,310	51,310	51,310
Kennedale	483	2,420	3,378	4,048	4,476	4,802
Lake Worth	3,053	3,553	4,122	4,686	5,278	5,573
North Richland Hills	18,226	20,801	22,533	23,737	24,496	25,009
Watauga	23,423	24,632	25,000	25,000	25,000	25,000
Northlake	1,700	2,487	2,877	5,530	8,182	9,842
Richland Hills	5,477	5,985	6,518	7,148	7,522	7,682
Roanoke	5,971	9,132	12,199	15,282	20,642	25,228
Saginaw	18,813	22,803	25,711	27,829	29,373	30,499
Sansom Park Village	372	426	437	417	442	495
Southlake (Tarrant & Denton Co)	28,019	29,636	30,107	31,924	34,188	36,000
Tarrant County-Other	12,936	12,697	12,505	12,219	12,123	12,123
Trophy Club	6,025	7,064	7,954	8,730	9,568	10,416
Westover Hills	658	658	658	658	658	658
Westworth Village	3,224	3,403	3,618	3,869	4,156	4,586
White Settlement	9,512	10,540	11,394	12,236	13,694	15,180
Kemp	1,400	1,700	2,000	2,000	2,000	2,000
Mabank (Henderson & Kaufman Co.)	3,074	3,729	4,401	5,142	6,058	7,194
GBC (added by LPB)	3,065	2,880	3,302	3,735	4,263	4,930
Malakoff	1,195	1,265	1,339	1,409	1,502	1,614
Mansfield	57,337	87,375	108,258	123,658	139,058	154,458
Johnson County SUD	8,791	17,242	33,744	32,640	31,639	31,628
Grand Prairie	0	67,198	79,202	89,146	99,604	99,604
River Oaks	7,100	7,100	7,100	7,100	7,100	7,100
Runaway Bay	1,411	1,720	2,097	2,400	2,700	3,000
Springtown	1,596	2,568	3,540	4,524	5,516	6,512
Reno	1,223	1,284	1,329	1,362	1,427	1,515
Trinity River Authority	0	0	0	0	0	0
Bedford	44,551	46,841	48,749	50,320	51,710	52,900
Buena Vista Bethel SUD	2,901	4,089	5,487	7,075	8,811	10,701
Ennis (by 2030)	103	105	101	2,154	15,827	23,226
Community Water Company (Ellis County)	0	1,414	1,690	1,972	2,288	0
Rice WSC	0	417	421	429	429	0
Ellis County-Other (by 2020)	0	299	303	305	31	0
Ferris (by 2020)	1,142	1,476	1,839	2,305	2,880	3,380
Palmer (by 2020)	0	0	0	0	0	0
Italy (by 2020)	0	356	638	953	1,329	1,768
Euless	45,803	52,622	55,936	57,553	58,287	58,715
North Richland Hills	45,403	51,452	55,539	58,300	60,166	61,426
Maypearl (by 2020)	0	0	0	0	0	0
Midlothian	0	13,368	26,851	38,932	51,987	65,131
Grand Prairie	0	72,803	85,808	96,581	107,912	107,912
Venus (Region G)	2,435	2,435	2,435	2,435	2,435	2,435
Rockett SUD	21,073	29,038	41,003	50,936	56,255	56,890
Oak Leaf	245	248	251	252	254	255
Lancaster	608	597	653	653	653	653
Red Oak	625	1,050	1,300	1,400	1,500	1,600
Pecan Hill	813	943	1,072	1,203	1,350	1,512
Waxahachie	30,000	39,000	46,342	59,322	75,937	97,206
Colleyville	22,099	25,564	25,536	25,536	25,536	25,536

WUGs	2011 Population Revisions Applied to TRWD					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
Grapevine	28,398	32,230	36,840	37,620	38,220	38,700
Walnut Creek SUD	21,343	31,654	50,123	62,000	65,500	68,000
Boyd	453	920	1,395	1,866	2,356	2,356
Rhome	953	1,969	3,621	5,322	7,022	8,723
New Fairview	0	407	956	1,513	2,145	2,876
Newark	0	482	1,027	1,968	3,121	4,880
Paradise	563	691	848	1,041	1,278	1,568
Sanctuary	715	1,675	2,435	2,875	3,305	3,708
Weatherford	12,390	18,414	23,825	28,984	34,531	40,770
Hudson Oaks (starting by 2010)	574	995	1,522	2,041	2,544	3,042
Parker County Other	0	1,867	1,915	1,933	1,825	1,715
West Cedar Creek MUD	17,100	22,567	28,089	34,021	41,323	50,443
Seven Points	1,402	1,681	1,956	2,238	2,582	3,016
Tool	2,618	2,990	3,357	3,733	4,192	4,771
West Wise Rural WSC	3,474	3,864	4,287	4,758	5,283	5,865
Chico	525	708	992	1,382	1,874	2,472
Freestone County Other	9,298	9,717	9,935	9,998	9,998	9,998
Henderson County-Other	401	398	398	395	399	399
Kaufman County-Other	2,753	2,753	2,753	2,753	2,753	2,753
Navarro County-Other	704	708	708	702	708	708
Wise County-Other	15,901	17,609	17,609	17,609	17,609	17,609
Subtotal - Existing	**1,893,627**	**2,614,156**	**3,064,595**	**3,510,804**	**4,007,407**	**4,543,477**
Potential Future Customers						
Annetta (through Weatherford)	0	185.368	487.557	748.688	1022.448	1343.448
Annetta South (through Weatherford)	0	40.128	129.582	199.432	290.857	392.64
Aurora (through Rhome through Walnut Creek SUD)	0	412.2	422	425.502	428.697	737.87
Bardwell	0	140.825	354.468	585.934	850.297	1146.208
Corsicana	0	0	4073.93384	6843.886067	10602.39923	15786.30941
Fairfield	0	0	0	30.5	800.4	1395
Files Valley SUD	0	986.3354037	992.3652695	1002.322206	1000.973574	993.5185185
Mountain Peak SUD	859.248	3296.246	3723.237	4901.607	7012.28	9741.187
Pantego	0	669.902	676.856	676.856	690.764	690.764
Pelican Bay	0	344.4	765.072	970.79	1243.644	1582.056
Sardis-Lone Elm WSC	0	10455.472	14385.848	14325.74	14305.704	14305.704
Willow Park	0	1115.49	3451.926	5140	6305.6	7104
Subtotal - Potential	859.248	17646.3664	29462.84511	35851.25727	44554.06381	55218.70493
TOTAL	**1,894,486**	**2,631,803**	**3,094,058**	**3,546,655**	**4,051,961**	**4,598,696**

Projected Demand for Customers of Dallas - Gross and Net

WUGs	Demand on DWU					
	2010	2020	2030	2040	2050	2060
Addison	7,904	10,074	10,919	11,514	11,918	12,218
Carrollton	25,887	26,113	26,772	27,065	27,356	27,632
Hebron	114	111	110	109	109	109
Cedar Hill	9,829	14,076	16,431	17,005	17,005	17,005
Cockrell Hill	653	687	681	670	667	668
Coppell	11,544	11,500	11,447	11,434	11,417	11,440
Dallas	374,848	399,421	416,979	442,190	486,268	567,304
Balch Springs	2,621	2,730	2,805	2,852	2,934	3,028
Dallas County - Other	95	73	55	40	30	23
Denton Total	0	0	7,051	18,243	31,801	58,323
DeSoto	10,355	12,375	14,162	15,807	17,741	18,271
Duncanville	7,605	7,563	7,522	7,439	7,356	7,356
Farmers Branch	11,229	12,109	12,883	13,603	14,286	14,945
Flower Mound	8,662	10,435	12,320	12,320	12,320	12,320
Glenn Heights	1,407	1,674	1,961	2,247	2,528	2,834
Oak Leaf	283	338	393	448	512	585
Grand Prairie Total	23,813	16,174	21,334	26,159	31,233	31,233
Grapevine Total	3,864	3,565	3,530	3,153	2,887	2,697
Hutchins	821	1,008	1,255	1,624	2,123	3,497
Wilmer	121	205	290	552	1,309	2,241
Irving	15,765	18,750	4,000	4,000	4,000	4,000
Lancaster	5,614	8,665	9,346	9,273	9,273	9,273
Lewisville	19,263	21,317	23,506	26,051	29,517	33,613
Denton County FWSD NO. 1A	99	522	704	892	1,084	1,285
Ovilla	936	1,494	2,043	2,592	2,728	2,929
Red Oak	1,893	3,419	4,430	5,006	5,331	5,687
Seagoville	2,085	2,542	3,019	3,480	3,890	4,191
Combine WSC	462	688	855	1,035	1,268	1,562
Combine	282	356	405	463	537	635
The Colony	5,185	7,000	7,748	7,929	8,105	8,178
UTRWD Current Contract	10,000	46,290	56,656	58,438	60,066	61,638
UTRWD Additional						11,210
Collin County Irrigation	2,950	2,950	2,950	2,950	2,950	2,950
Dallas County Irrigation	8,768	8,768	8,768	8,768	8,768	8,768
Dallas County - Manufacturing	24,904	27,587	30,038	32,276	34,093	34,298
Dallas County - Mining	298	304	303	303	303	303
Dallas County - Raw Water for Steam E	3,367	4,290	5,000	5,000	5,000	5,000
Denton County Irrigation	2,400	2,400	2,400	2,400	2,400	2,400
Denton County Manufacturing	427	496	563	632	692	752
Rockwall Co Irrigation	277	277	277	277	277	277
Total Current Customers	**606,630**	**688,346**	**731,911**	**786,239**	**862,082**	**992,678**
Potential Future Customers						
Crandall (direct or through Seagoville)	0	347	601	672	1,037	1,490
Total	**606,630**	**688,693**	**732,512**	**786,911**	**863,119**	**994,168**

Projected Municipal Demand for Customers of Tarrant Regional Water District

	2011 Revised Demand Applied to TRWD					
WUGs	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Arlington	67,540	74,913	79,067	82,535	82,156	82,306
Grand Prairie (through Arlington)	0.00	4,484.00	4,484.00	4,484.00	4,484.00	4,484.00
Bethesda WSC	0	1,489	1,833	2,214	2,678	3,266
Azle	1,953	2,633	3,602	4,697	5,849	6,860
Benbrook	4,409	6,140	6,721	7,984	9,489	11,254
Blue Mound	0	0	0	0	0	0
Bridgeport	1,361	1,899	2,702	3,187	3,713	4,444
Community WSC	444	438	433	422	426	435
Decatur	1,639	2,011	2,748	3,537	4,580	5,385
East Cedar Creek FWSD	1,698	1,866	2,215	2,382	2,580	2,777
Gun Barrel City	704	977	1,104	1,243	1,411	1,632
Fort Worth	173,064	214,926	258,772	313,677	384,126	471,992
Aledo	0	456	1,031	1,605	1,712	1,712
Bethesda WSC	3,483	2,978	3,666	4,428	5,357	6,533
Burleson	5,248	7,676	9,462	9,550	9,749	10,062
Crowley	1,238	1,548	2,049	2,881	3,547	3,893
Dalworthington Gardens	505	550	581	596	608	618
Denton County-Other	445	579	663	743	825	908
Edgecliff	460	451	443	434	428	428
Everman	239	266	244	222	215	215
Forest Hill	1,492	1,584	1,671	1,776	1,912	2,008
Grand Prairie (through Fort	1,121	1,121	1,121	1,121	1,121	1,121
Haltom City	6,521	7,835	8,142	8,231	8,272	8,324
Haslet	663	1,434	2,576	2,568	2,561	2,561
Hurst	6,708	6,991	6,854	6,716	6,670	6,670
Keller	9,124	10,138	11,495	11,380	11,380	11,380
Kennedale	86	425	587	698	768	823
Lake Worth	585	665	757	845	945	999
North Richland Hills	3,516	3,917	4,193	4,357	4,475	4,574
Watauga	3,437	3,532	3,500	3,416	3,388	3,388
Northlake	268	404	467	898	1,329	1,599
Richland Hills	865	919	979	1,049	1,096	1,118
Roanoke	1,498	2,474	3,280	4,090	5,529	6,755
Saginaw	3,161	3,755	4,176	4,489	4,705	4,885
Sansom Park Village	51	57	57	53	56	63
Southlake (Tarrant & Denton Co)	9,321	9,826	9,949	10,514	11,259	11,855
Tarrant County Other	1,885	1,805	1,751	1,671	1,644	1,644
Trophy Club	2,077	2,420	2,707	2,962	3,249	3,536
Westover Hills	276	274	272	270	268	268
Westworth Village	350	412	426	442	470	519
White Settlement	1,524	1,640	1,735	1,824	2,024	2,246
Gun Barrel City		652	736	828	941	1,088
Kemp	224	267	307	300	296	296
Mabank (Henderson & Kaufman	671	801	931	1,083	1,269	1,507
Gun Barrel City	704	652	736	828	941	1,088
Malakoff	174	180	186	191	202	217
Mansfield	13,632	19,020	24,481	29,385	33,043	36,701
Grand Prairie (through Mansfield)	0	6,726	6,726	6,726	6,726	6,726
Johnson County SUD (through Mansfield)	1,682	3,363	6,726	6,726	6,726	6,726
Reno (thru Springtown & Walnut Creek SUD)	152	154	155	154	160	170
River Oaks	1,010	986	954	931	923	923
Runaway Bay	296	356	430	489	547	608
Springtown	268	423	571	725	877	1,036
Trinity River Authority						
Bedford	9,029	9,338	9,556	9,699	9,908	10,137
Colleyville	7,324	8,391	8,328	8,297	8,265	8,265
Ennis Total	***5,467***	***6,403***	***7,596***	***3,922***	***3,891***	***5,439***
Ferris	174	220	268	328	403	473
Grapevine	9,551	10,717	12,167	12,344	12,503	12,666
Euless	8,314	9,376	9,774	9,924	9,993	10,064
North Richland Hills	8,747	9,682	10,327	10,710	10,985	11,215
Midlothian Total	***1,020***	***10,882***	***13,512***	***15,701***	***17,923***	***20,033***
Venus (Region G)	363	358	349	344	342	342
Rockett SUD Total	***3,910***	***4,974***	***6,503***	***7,754***	***8,418***	***8,549***
Waxahachie Total	***2,500***	***2,660***	***4,830***	***10,344***	***16,627***	***22,299***
Walnut Creek SUD	2,606	3,794	5,895	7,222	7,631	7,922
Boyd	65	128	189	247	309	309
Rhome	347	712	1298	1908	2517	3126
New Fairview	0	51	119	188	267	358
Newark	0	63	132	249	395	618
Paradise	73	89	109	134	165	202
Sanctuary	92	216	314	370	426	478
Weatherford	2,542	3,694	4,727	5,717	6,768	7,991

	2011 Revised Demand Applied to TRWD					
WUGs	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Hudson Oaks	113	194	295	393	490	586
Parker County Other	0	228	230	227	213	200
Parker County SEP	24	22	28	56	75	102
West Cedar Creek MUD	1,724	2,604	3,335	4,002	4,860	5,933
Seven Points	188	222	254	288	330	385
Tool	405	452	500	548	610	695
West Wise Rural WSC	483	524	567	618	681	756
Chico	84	111	152	209	281	371
Freestone County Other (part)	285	344	388	400	400	400
Henderson County-Other	79	77	76	74	74	74
Kaufman County-Other	416	413	410	407	404	404
Navarro County-Other	100	98	96	93	92	92
Wise County-Other	1,888	2,130	2,110	2,071	2,051	2,051
Freestone County Steam Electric	6,726	7,726	7,726	7,726	7,726	7,726
Henderson County SEP	0	0	3,950	4,950	5,950	6,950
Henderson County Mining	79	91	98	106	113	120
Jack County-SEP	2,162	2,500	2,700	2,900	3,100	3,300
Kaufman County Irrigation	100	100	100	100	100	100
50% of Navarro County	586	664	734	803	865	936
Parker County Manufacturing	623	703	779	854	920	998
Tarrant County Manufacturing	17,258	20,444	23,630	26,924	29,919	32,457
Tarrant County Mining	536	452	469	487	504	518
Tarrant County Irrigation	5,518	4,208	4,208	4,208	4,208	4,208
Tarrant County Steam Electric	2,640	2,448	2,640	2,640	2,640	2,640
Wise County Irrigation	212	212	212	212	212	212
Wise County Manufacturing	2,299	2,646	2,965	3,263	3,525	3,844
Wise County Steam Electric Power	1,751	1,245	1,216	1,878	2,042	2,748
Wise County Mining	7,943	8,677	9,486	10,318	11,177	11,987
Subtotal - Existing	**459,585**	**576,461**	**671,684**	**763,086**	**869,304**	**994,702**
Potential Future Customers						
Alvord (through West Wise WSC)	0	150	150	150	150	150
Alvarado (Region G)	0	444	484	521	580	658
Annetta (through Weatherford)	0	25	65	99	134	176
Annetta South (through	0	5	16	24	35	47
Aurora (through Rhome through	0	50	50	50	50	86
Bardwell	0	17	42	69	100	135
Total, Corsicana and Customers	***0***	***0***	***1,628***	***2,547***	***3,702***	***5,172***
Fairfield	0	0	0	6	169	296
Mountain Peak SUD (through	155	586	658	856	1,224	1,701
Pantego	0	200	200	200	200	200
Pelican Bay	0	36	90	112	142	181
Sardis-Lone Elm WSC	0	2,155	2,934	2,890	2,867	2,867
Willow Park	0	177	541	800	974	1,098
Subtotal - Potential	**155**	**3,845**	**6,858**	**8,324**	**10,327**	**12,767**
TOTAL	**459,740**	**580,306**	**678,542**	**771,410**	**879,631**	**1,007,469**

PROJECT BUDGET - Entity Name - Tarrant Regional Water District (City of Dallas)						
Uses	**TWDB Funds Series 1**	**TWDB Funds Series 2**	**TWDB Funds Series 3**	**Total TWDB Cost**	**Other Funds**	**Total Cost**
Construction						
Construction	$94,490,000	$0	$0	$94,490,000	$13,030,000	$107,520,000
Subtotal Construction	**$94,490,000**	**$0**	**$0**	**$94,490,000**	**$13,030,000**	**$107,520,000**
Basic Engineering Fees						
Planning +	$0	$0	$0	$0	$0	$0
Design	$720,000	$0	$0	$720,000	$8,100,000	$8,820,000
Construction Engineering	$1,680,000	$0	$0	$1,680,000	$6,750,000	$8,430,000
Basic Engineering Other **_____	$0	$0	$0	$0	$0	$0
Subtotal Basic Engineering Fees	**$2,400,000**	**$0**	**$0**	**$2,400,000**	**$14,850,000**	**$17,250,000**
Special Services						
Application	$0	$0	$0	$0	$0	$0
Environmental	$0	$0	$0	$0	$0	$0
Water Conservation Plan	$0	$0	$0	$0	$0	$0
I/I Studies/Sewer Evaluation	$0	$0	$0	$0	$0	$0
Surveying	$1,310,000	$0	$0	$1,310,000	$0	$1,310,000
Geotechnical	$0	$0	$0	$0	$0	$0
Testing	$740,000	$0	$0	$740,000	$590,000	$1,330,000
Permits	$0	$0	$0	$0	$0	$0
Inspection	$0	$0	$0	$0	$0	$0
O&M Manual	$0	$0	$0	$0	$0	$0
Project Management (by engineer)	$7,940,000	$0	$0	$7,940,000	$2,240,000	$10,180,000
Pilot Testing	$0	$0	$0	$0	$0	$0
Water Distribution Modeling	$0	$0	$0	$0	$0	$0
Special Services Other **_____	$0	$0	$0	$0	$0	$0
Subtotal Special Services	**$9,990,000**	**$0**	**$0**	**$9,990,000**	**$2,830,000**	**$12,820,000**
Other						
Administration	$10,850,000	$0	$0	$10,850,000	$12,110,000	$22,960,000
Land/Easements Acquisition	$12,770,000	$0	$0	$12,770,000	$12,030,000	$24,800,000
Water Rights Purchase (If Applicable)	$0	$0	$0	$0	$0	$0
Capacity Buy-In (If Applicable)	$0	$0	$0	$0	$0	$0
Project Legal Expenses	$0	$0	$0	$0	$0	$0
Other **	$0	$0	$0	$0	$0	$0
Subtotal Other Services	**$23,620,000**	**$0**	**$0**	**$23,620,000**	**$24,140,000**	**$47,760,000**
Fiscal Services						
Financial Advisor	$0	$0	$0	$0	$0	$0
Bond Counsel	$0	$0	$0	$0	$0	$0
Issuance Cost	$420,000	$0	$0	$420,000	$310,000	$730,000
Bond Insurance/Surety	$0	$0	$0	$0	$0	$0
Fiscal/Legal	$0	$0	$0	$0	$0	$0
Capitalized Interest	$0	$0	$0	$0	$0	$0
Bond Reserve Fund	$8,170,000	$0	$0	$8,170,000	$6,970,000	$15,140,000
Loan Origination Fee	$0	$0	$0	$0	$0	$0
Other **	$0	$0	$0	$0	$0	$0
Subtotal Fiscal Services	**$8,590,000**	**$0**	**$0**	**$8,590,000**	**$7,280,000**	**$15,870,000**
Contingency						
Contingency	$910,000	$0	$0	$910,000	$4,870,000	$5,780,000
Subtotal Contingency	**$910,000**	**$0**	**$0**	**$910,000**	**$4,870,000**	**$5,780,000**
TOTAL COSTS	**$140,000,000**	**$0**	**$0**	**$140,000,000**	**$67,000,000**	**$207,000,000**

Other ** description must be entered

+ For Planning applications under the EDAP Program, please break down Planning costs as follows:

Category A			0
Category B			0
Category C			0
Category D			0
Total Planning Costs	0	0	0

PROJECT BUDGET - Entity Name - Tarrant Regional Water District - TRWD Bond						
Uses	**TWDB Funds Series 1**	**TWDB Funds Series 2**	**TWDB Funds Series 3**	**Total TWDB Cost**	**Other Funds**	**Total Cost**
Construction						
Construction	$217,630,000	$0	$0	$217,630,000	$123,270,000	$340,900,000
Subtotal Construction	**$217,630,000**	**$0**	**$0**	**$217,630,000**	**$123,270,000**	**$340,900,000**
Basic Engineering Fees						
Planning +	$0	$0	$0	$0	$0	$0
Design	$1,250,000	$0	$0	$1,250,000	$0	$1,250,000
Construction Engineering	$4,540,000	$0	$0	$4,540,000	$3,970,000	$8,510,000
Basic Engineering Other ** _____	$0	$0	$0	$0	$0	$0
Subtotal Basic Engineering Fees	**$5,790,000**	**$0**	**$0**	**$5,790,000**	**$3,970,000**	**$9,760,000**
Special Services						
Application	$0	$0	$0	$0	$0	$0
Environmental	$0	$0	$0	$0	$0	$0
Water Conservation Plan	$0	$0	$0	$0	$0	$0
I/I Studies/Sewer Evaluation	$0	$0	$0	$0	$0	$0
Surveying	$1,430,000	$0	$0	$1,430,000	$0	$1,430,000
Geotechnical	$0	$0	$0	$0	$0	$0
Testing	$2,090,000	$0	$0	$2,090,000	$1,800,000	$3,890,000
Permits	$0	$0	$0	$0	$0	$0
Inspection	$0	$0	$0	$0	$0	$0
O&M Manual	$0	$0	$0	$0	$0	$0
Project Management (by engineer)	$14,910,000	$0	$0	$14,910,000	$6,700,000	$21,610,000
Pilot Testing	$0	$0	$0	$0	$0	$0
Water Distribution Modeling	$0	$0	$0	$0	$0	$0
Special Services Other ** _____	$0	$0	$0	$0	$0	$0
Subtotal Special Services	**$18,430,000**	**$0**	**$0**	**$18,430,000**	**$8,500,000**	**$26,930,000**
Other						
Administration	$15,960,000	$0	$0	$15,960,000	$16,300,000	$32,260,000
Land/Easements Acquisition	$24,660,000	$0	$0	$24,660,000	$17,970,000	$42,630,000
Water Rights Purchase (If Applicable)	$0	$0	$0	$0	$0	$0
Capacity Buy-In (If Applicable)	$0	$0	$0	$0	$0	$0
Project Legal Expenses	$0	$0	$0	$0	$0	$0
Other **	$0	$0	$0	$0	$0	$0
Subtotal Other Services	**$40,620,000**	**$0**	**$0**	**$40,620,000**	**$34,270,000**	**$74,890,000**
Fiscal Services						
Financial Advisor	$0	$0	$0	$0	$0	$0
Bond Counsel	$0	$0	$0	$0	$0	$0
Issuance Cost	$790,000	$0	$0	$790,000	$650,000	$1,440,000
Bond Insurance/Surety	$0	$0	$0	$0	$0	$0
Fiscal/Legal	$0	$0	$0	$0	$0	$0
Capitalized Interest	$0	$0	$0	$0	$0	$0
Bond Reserve Fund	$15,120,000	$0	$0	$15,120,000	$14,380,000	$29,500,000
Loan Origination Fee	$0	$0	$0	$0	$0	$0
Other **	$0	$0	$0	$0	$0	$0
Subtotal Fiscal Services	**$15,910,000**	**$0**	**$0**	**$15,910,000**	**$15,030,000**	**$30,940,000**
Contingency						
Contingency	$1,620,000	$0	$0	$1,620,000	$9,660,000	$11,280,000
Subtotal Contingency	**$1,620,000**	**$0**	**$0**	**$1,620,000**	**$9,660,000**	**$11,280,000**
TOTAL COSTS	**$300,000,000**	**$0**	**$0**	**$300,000,000**	**$194,700,000**	**$494,700,000**

Other ** description must be entered

+ For Planning applications under the EDAP Program, please break down Planning costs as follows:

Category A			0
Category B			0
Category C			0
Category D			0
Total Planning Costs	0	0	0

Texas Water Development Board
Water Project Information

A. Project Name	B. Project No.	C. County	D. Regional Planning Group (A-P)
Integrated Pipeline Project		Tarrant, Johnson, Ellis, Henderson, Navarro	C
E. Program(s)	F. Loan ■ / Grant ☐ Amount:	G. Loan Term:	
SWIFT	$440,000,000	30 year	

H. Water Project Description: (Multiphase project, new or expansion; plant, well, storage, pump station, distribution system, etc)

TRWD and DWU have partnered to finance, plan, design construct and operate the Integrated Pipeline (IPL) Project. The IPL Project is an integrated water delivery transmission system connecting Lake Palestine to Lake Benbrook with connections to Cedar Creek and Richland-Chambers Reservoirs integrating TRWD•s existing pipelines and creating flexibility in delivery as well as quick response to fluctuating customer water demands. The IPL Project consists of 150 miles of pipeline, three new lake pump stations, and three new booster pump stations delivering a required capacity of 350 million gallons per day (MGD) of raw water to North Central Texas.

Attach map of service area affected by Project or other documentation.

I. Is an Inter Basin Transfer potentially involved?	J. Is project located in a Groundwater District (If yes, identify District by name)?
Yes ☐ No ☐	Yes ☐ Neches and Trinity Valley GCD, Prairielands GCD and Northern Trinity GCD No ☐

K. Projected Population from application for at least a 20 year period. Attach justification and list service area populations if different from Planning Area.	Year	Reference Year	2010	2020	2030	2040	2060
	Population Projection	2010	4,108,696	5,223,050,	5,885,408	6,584,423	8,511,549

Project Design Year	2060	Design Population	8,511,549

L. Is the proposed project included in a current Regional Water Plan? Yes☐ No ☐ Don't Know ☐
(If Yes, please specify on what page in the Regional Water Plan - Regional Water Plan Page Number: P 4E.18 Table 4E.3; P.4E.14 Table 4E.3

M. What type of water source is associated directly with the proposed project? Surface Water■ Groundwater☐ Reuse☐

N. Will the project increase the volume of water supply? Yes ■ No ☐

O. What volume of water is the project anticipated to deliver/ treat per year? 392,077.07 Acre-Feet/Year

P. Current Water Supply Information

Surface Water Supply Source / Provider Names	Certificate No.	Source County	Annual Volume and Unit
			263,059 acre ft/yr 310,465 acre ft/yr
Groundwater Source Aquifer	**Well Field location**	**Source County**	**Annual Volume and Unit**

Q. Proposed Water Supply Associated Directly with the Proposed Project

Surface Water Supply Source / Provider Names	Certificate No.	Source County	Annual Volume and Unit
		Henderson, Navarro/Freestone	263,059 acre ft/yr 310,465 acre ft/yr
Groundwater Source Aquifer	**Well Field location:**	**Source County**	**Annual Volume and Unit**

R. Consulting Engineer Name	Telephone No.	E-mail address
	817-720-4255	ed.weaver@trwd.com
S. Applicant Contact Name, Title	Telephone No.	E-mail address
	817-720-4364	sandy.newby@trwd.com

Integrated Pipeline Program
Current Construction Schedule
TWDB

PL 10/PL 11
Start: 3/1/2016
End: 2/28/2018

DWU
Start: 1/1/2016
End: 6/1/2017

PL 9
Start: 1/3/2033
End: 7/5/2035

PL 12/PL 13/MBR
Start: 11/10/2014
End: 4/7/2017

JB4
Start: 7/1/2031
End: 7/3/2035

JB4 Bypass
Start: 3/1/2016
End: 2/28/2018

Existing TRWD Pipelines

JB3
Start: 7/21/2014
End: 2/13/2018

PL 14
Start: 1/1/2016
End: 10/31/2017

PL 15-2
Start: 7/16/2015
End: 7/19/2017

PL 15-1
Start: 5/1/2014
End: 8/6/2015

PL 17/PL 18
Start: 3/1/2016
End: 11/30/2020

JCC1 Intake
Start: 12/1/2016
End: 5/31/2019

JCC1 PS
Start: 11/29/2018
End: 6/01/2021

JB2
Start: 7/1/2026
End: 7/3/2030

PL 16
Start: 9/1/2028
End: 3/10/2031

JRC1
Start: 7/1/2028
End: 7/3/2032

PL 19-1
Start: 7/1/2020
End: 12/28/2022

PL 19-2
Start: 1/2/2022
End: 7/3/2024

LP1 Intake
Start: 7/1/2020
End: 12/29/2022

LP1 PS
Start: 7/3/2022
End: 12/31/2024

Includes Land Cost for IPL Section 9, 16, 19-2 and 19-1

Projected Population for Customers of Dallas

WUGs	2011 Population Revisions Applied to DWU					
	2010	2020	2030	2040	2050	2060
Addison	16,000	20,534	22,358	23,629	24,515	25,133
Carrollton	121,000	124,000	128,500	131,320	133,450	134,800
Hebron	500	500	500	500	500	500
Cedar Hill	45,006	65,460	76,836	80,316	80,316	80,316
Cockrell Hill	4,782	4,947	5,028	5,067	5,086	5,095
Coppell	40,415	40,577	40,715	40,832	40,932	41,016
Dallas	1,312,324	1,415,000	1,495,000	1,598,223	1,764,681	2,058,767
Balch Springs	21,083	22,564	23,849	24,963	25,930	26,768
Dallas County - Other	737	572	444	339	267	201
Denton	0	0	34,265	89,385	156,342	288,625
DeSoto	47,649	57,243	65,849	73,881	82,923	85,400
Duncanville	37,100	37,100	37,100	37,100	37,100	37,100
Farmers Branch	30,470	33,161	35,608	37,833	39,855	41,693
Flower Mound	33,334	34,000	35,712	35,712	35,712	35,712
Glenn Heights	11,423	13,833	16,516	19,102	21,705	24,332
Oak Leaf	1,257	1,526	1,791	2,064	2,368	2,705
Grand Prairie	138,890	79,184	109,037	135,988	164,725	164,725
Grapevine	11,503	10,725	10,680	9,600	8,820	8,220
Hutchins	3,200	4,000	5,000	6,500	8,500	14,000
Wilmer	1,037	1,712	2,465	4,740	11,242	19,228
Irving	59,413	67,228	14,584	14,459	14,390	14,460
Lancaster	37,392	59,067	64,648	64,648	64,648	64,648
Lewisville	97,709	110,002	122,002	136,002	155,002	176,515
Denton County FWSD NO. 1A	309	1,634	2,211	2,805	3,408	4,039
Ovilla	3,634	5,851	8,066	10,287	10,829	11,621
Red Oak	10,000	17,850	23,400	26,600	28,500	30,400
Seagoville	13,017	16,327	19,537	22,848	25,536	27,517
Combine WSC	4,122	5,737	7,202	8,795	10,785	13,285
Combine	2,393	2,969	3,474	4,019	4,702	5,563
The Colony	36,450	50,400	56,700	58,500	60,300	60,840
UTRWD	72,061	287,544	322,273	331,711	339,917	346,339
UTRWD Add'l						63,290
Total	**2,214,210**	**2,591,247**	**2,791,350**	**3,037,768**	**3,362,986**	**3,912,853**

Projected Population for Customers of Tarrant Regional Water District

WUGs	2011 Population Revisions Applied to TRWD					
	2010	2020	2030	2040	2050	2060
Arlington	331,146	373,575	398,700	421,082	421,554	422,498
Grand Prairie (through Arlington)	0	44,799	44,799	44,799	44,799	44,799
Bethesda WSC	0	10,551	13,196	16,069	19,598	23,900
Azle	12,108	16,795	23,473	31,060	38,682	45,362
Benbrook	18,912	27,000	30,000	36,000	43,000	51,000
Blue Mound	0	0	0	0	0	0
Bridgeport	5,900	8,352	12,001	14,296	16,657	19,936
Community WSC	3,536	3,588	3,642	3,699	3,767	3,847
Decatur	6,804	8,508	11,738	15,253	19,751	23,225
East Cedar Creek FWSD	9,973	11,178	13,363	14,568	15,773	16,978
Gun Barrel City	3,066	4,321	4,954	5,603	6,395	7,394
Fort Worth	732,201	926,822	1,127,326	1,379,008	1,696,962	2,085,879
Aledo	0	2,675	6,138	9,616	10,262	10,262
Bethesda WSC	24,111	21,117	26,383	32,129	39,172	47,768
Burleson	32,091	48,255	60,336	61,782	63,517	65,567
Crowley	8,190	10,549	14,181	20,246	25,128	27,589
Dalworthington Gardens	1,616	1,786	1,901	1,969	2,020	2,052
Denton County-Other	2,137	2,822	3,271	3,686	4,090	4,506
Edgecliff	2,550	2,550	2,550	2,550	2,550	2,550
Everman	1,922	2,198	2,072	1,940	1,901	1,901
Forest Hill	12,000	13,090	14,210	15,392	16,738	17,574
Grand Prairie	6,460	89,180	90,787	91,265	90,642	90,642
Haltom City	41,000	50,322	53,058	54,428	55,113	55,456
Haslet	1,692	3,688	6,685	6,685	6,685	6,685
Hurst	34,635	36,695	36,654	36,572	36,531	36,531
Keller	40,127	45,026	51,310	51,310	51,310	51,310
Kennedale	483	2,420	3,378	4,048	4,476	4,802
Lake Worth	3,053	3,553	4,122	4,686	5,278	5,573
North Richland Hills	18,226	20,801	22,533	23,737	24,496	25,009
Watauga	23,423	24,632	25,000	25,000	25,000	25,000
Northlake	1,700	2,487	2,877	5,530	8,182	9,842
Richland Hills	5,477	5,985	6,518	7,148	7,522	7,682
Roanoke	5,971	9,132	12,199	15,282	20,642	25,228
Saginaw	18,813	22,803	25,711	27,829	29,373	30,499
Sansom Park Village	372	426	437	417	442	495
Southlake (Tarrant & Denton Co)	28,019	29,636	30,107	31,924	34,188	36,000
Tarrant County-Other	12,936	12,697	12,505	12,219	12,123	12,123
Trophy Club	6,025	7,064	7,954	8,730	9,568	10,416
Westover Hills	658	658	658	658	658	658
Westworth Village	3,224	3,403	3,618	3,869	4,156	4,586
White Settlement	9,512	10,540	11,394	12,236	13,694	15,180
Kemp	1,400	1,700	2,000	2,000	2,000	2,000
Mabank (Henderson & Kaufman Co.)	3,074	3,729	4,401	5,142	6,058	7,194
GBC (added by LPB)	3,065	2,880	3,302	3,735	4,263	4,930
Malakoff	1,195	1,265	1,339	1,409	1,502	1,614
Mansfield	57,337	87,375	108,258	123,658	139,058	154,458
Johnson County SUD	8,791	17,242	33,744	32,640	31,639	31,628
Grand Prairie	0	67,198	79,202	89,146	99,604	99,604
River Oaks	7,100	7,100	7,100	7,100	7,100	7,100
Runaway Bay	1,411	1,720	2,097	2,400	2,700	3,000
Springtown	1,596	2,568	3,540	4,524	5,516	6,512
Reno	1,223	1,284	1,329	1,362	1,427	1,515
Trinity River Authority	0	0	0	0	0	0
Bedford	44,551	46,841	48,749	50,320	51,710	52,900
Buena Vista Bethel SUD	2,901	4,089	5,487	7,075	8,811	10,701
Ennis (by 2030)	103	105	101	2,154	15,827	23,226
Community Water Company (Ellis County)	0	1,414	1,690	1,972	2,288	0
Rice WSC	0	417	421	429	429	0
Ellis County-Other (by 2020)	0	299	303	305	31	0
Ferris (by 2020)	1,142	1,476	1,839	2,305	2,880	3,380
Palmer (by 2020)	0	0	0	0	0	0
Italy (by 2020)	0	356	638	953	1,329	1,768
Euless	45,803	52,622	55,936	57,553	58,287	58,715
North Richland Hills	45,403	51,452	55,539	58,300	60,166	61,426
Maypearl (by 2020)	0	0	0	0	0	0
Midlothian	0	13,368	26,851	38,932	51,987	65,131
Grand Prairie	0	72,803	85,808	96,581	107,912	107,912
Venus (Region G)	2,435	2,435	2,435	2,435	2,435	2,435
Rockett SUD	21,073	29,038	41,003	50,936	56,255	56,890
Oak Leaf	245	248	251	252	254	255
Lancaster	608	597	653	653	653	653
Red Oak	625	1,050	1,300	1,400	1,500	1,600
Pecan Hill	813	943	1,072	1,203	1,350	1,512
Waxahachie	30,000	39,000	46,342	59,322	75,937	97,206
Colleyville	22,099	25,564	25,536	25,536	25,536	25,536

WUGs	2011 Population Revisions Applied to TRWD					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
Grapevine	28,398	32,230	36,840	37,620	38,220	38,700
Walnut Creek SUD	21,343	31,654	50,123	62,000	65,500	68,000
Boyd	453	920	1,395	1,866	2,356	2,356
Rhome	953	1,969	3,621	5,322	7,022	8,723
New Fairview	0	407	956	1,513	2,145	2,876
Newark	0	482	1,027	1,968	3,121	4,880
Paradise	563	691	848	1,041	1,278	1,568
Sanctuary	715	1,675	2,435	2,875	3,305	3,708
Weatherford	12,390	18,414	23,825	28,984	34,531	40,770
Hudson Oaks (starting by 2010)	574	995	1,522	2,041	2,544	3,042
Parker County Other	0	1,867	1,915	1,933	1,825	1,715
West Cedar Creek MUD	17,100	22,567	28,089	34,021	41,323	50,443
Seven Points	1,402	1,681	1,956	2,238	2,582	3,016
Tool	2,618	2,990	3,357	3,733	4,192	4,771
West Wise Rural WSC	3,474	3,864	4,287	4,758	5,283	5,865
Chico	525	708	992	1,382	1,874	2,472
Freestone County Other	9,298	9,717	9,935	9,998	9,998	9,998
Henderson County-Other	401	398	398	395	399	399
Kaufman County-Other	2,753	2,753	2,753	2,753	2,753	2,753
Navarro County-Other	704	708	708	702	708	708
Wise County-Other	15,901	17,609	17,609	17,609	17,609	17,609
Subtotal - Existing	**1,893,627**	**2,614,156**	**3,064,595**	**3,510,804**	**4,007,407**	**4,543,477**
Potential Future Customers						
Annetta (through Weatherford)	0	185.368	487.557	748.688	1022.448	1343.448
Annetta South (through Weatherford)	0	40.128	129.582	199.432	290.857	392.64
Aurora (through Rhome through Walnut Creek SUD)	0	412.2	422	425.502	428.697	737.87
Bardwell	0	140.825	354.468	585.934	850.297	1146.208
Corsicana	0	0	4073.93384	6843.886067	10602.39923	15786.30941
Fairfield	0	0	0	30.5	800.4	1395
Files Valley SUD	0	986.3354037	992.3652695	1002.322206	1000.973574	993.5185185
Mountain Peak SUD	859.248	3296.246	3723.237	4901.607	7012.28	9741.187
Pantego	0	669.902	676.856	676.856	690.764	690.764
Pelican Bay	0	344.4	765.072	970.79	1243.644	1582.056
Sardis-Lone Elm WSC	0	10455.472	14385.848	14325.74	14305.704	14305.704
Willow Park	0	1115.49	3451.926	5140	6305.6	7104
Subtotal - Potential	859.248	17646.3664	29462.84511	35851.25727	44554.06381	55218.70493
TOTAL	**1,894,486**	**2,631,803**	**3,094,058**	**3,546,655**	**4,051,961**	**4,598,696**

CERTIFICATE OF ADJUDICATION

CERTIFICATE OF ADJUDICATION: 08-4976

OWNER: Tarrant County Water Control and Improvement District No. 1
P. O. Box 4508
Fort Worth, Texas 76106

COUNTIES: Henderson and Kaufman

PRIORITY DATE: May 28, 1956

WATERCOURSE: Cedar Creek, tributary of the Trinity River

BASIN: Trinity River

WHEREAS, by final decree of the 66th Judicial District Court of Hill County, in Cause No. 28,952 In Re: The Adjudication of Water Rights in the Middle Trinity River Segment of the Trinity River Basin dated September 4, 1986 a right was recognized under Permit 1909 authorizing the Tarrant County Water Control and Improvement District No. 1 to appropriate waters of the State of Texas as set forth below;

NOW, THEREFORE, this certificate of adjudication to appropriate waters of the State of Texas in the Trinity River Basin is isaued to the Tarrant County Water Control and Improvement District No. 1, subject to the following terms and conditions:

1. IMPOUNDMENT

Owner is authorized to maintain an existing dam and reaervoir on Cedar Creek (Cedar Creek Reservoir) and impound therein not to exceed 678,900 acre-feet of water. The dam is located in the Jonathan Ping Survey, Abstract 608 and the M. M. Sanola Survey, Abstract 697, Henderson County, Texas.

2. USE

A. Owner ia authorized to divert and use not to exceed 175,000 acre-feet of water per annum from Cedar Creek (Cedar Creek Reservoir) for municipal and industrial purposes.

B. Owner is authorized to use the water impounded in the reservoir for recreation purposes.

3. DIVERSION

A. Location

(1) At five pointa on the perimeter of Cedar Creek Reservoir in the M. M. Sanchez Survey, Abstract 697; the James Smith Survey, Abstract 742; the J. P. Brown Survey, Abstract 59 and the John Baker Survey, Abstract 1203, Henderson County, Texas.

(2) At one point on the perimeter of Cedar Creek Reservoir in the Ezekiel Higdon Survey, Abstract 197, Kaufman County, Texas.

B. Maximum combined rate: 247.54 cfs (111,393 gpm).

4. PRIORITY

The time priority of owner's right is May 28, 1956.

5. SPECIAL CONDITIONS

A. Owner shall maintain a suitable outlet in the aforessid dam authorized herein to allow the free passage of water that owner is not entitled to divert or impound.

B. Owner may transport the water authorized herein from Cedar Creek Reservoir to places of use in Tarrant, Navarro and Ellis Counties, or those portions of Henderson, Kaufman, Van Zandt and Johnson Counties within the Trinity River Watershed and is expressly granted the right to enter into contracts for the use of such water with cities, municipalities, industries, and other users of water.

The locations of pertinent features related to this certificate are shown on Pages 4, 8 and 9 of the Middle Trinity River Segment Certificates of Adjudication Maps, copies of which are located in the office of the Texas Water Commission, Austin, Texas.

This certificate of adjudication is issued subject to all terms, conditions and provisions in the final decree of the 66th Judicial District Court of Hill County, Texas, in Cause No. 28,952 In Re: The Adjudication of Water Rights in the Middle Trinity River Segment of the Trinity River Basin dated September 4, 1986 and supersedes all rights of the owner ssserted in that cause.

This certificate of adjudication is issued subject to senior and superior water rights in the Trinity River Basin.

This certificate of adjudication is issued subject to the Rules of the Texas Water Commission and its continuing right of supervision of State water resources consistent with the public policy of the State as set forth in the Texas Water Code.

TEXAS WATER COMMISSION

/s/ Paul Hopkins
Paul Hopkins, Chairman

DATE ISSUED:

MAY 05 1987

ATTEST:

/s/ Mary Ann Hefner
Mary Ann Hefner, Chief Clerk

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

THE STATE OF TEXAS
COUNTY OF TRAVIS
I hereby certify that this is a [illegible]
Texas Commission on Environmental [illegible]
which is filed in the permanent [illegible]
Given under my hand and the [illegible]

Bridget C. Bohac

Bridget C Bohac, Chief Clerk
Texas Commission on Environmental Quality

AMENDMENT TO CERTIFICATE OF ADJUDICATION

CERTIFICATE NO. 08-4976D

TYPE: §§11.122

Owner:	Tarrant Regional Water District	Address:	P.O. Box 4508 Fort Worth, Texas 76164
Filed:	October 29, 2013	Granted:	November 25, 2014
Purposes:	Municipal, Mining, Industrial and Agricultural	Counties:	Henderson and Kaufman
Watercourse:	Cedar Creek, tributary of the Trinity River	Watershed:	Trinity River Basin

WHEREAS, Certificate of Adjudication No. 08-4976 authorizes Tarrant Regional Water District (TRWD or Owner) to maintain an existing dam and reservoir on Cedar Creek (Cedar Creek Reservoir), tributary of the Trinity River, Trinity River Basin and impound not to exceed 678,900 acre-feet of water for recreational purposes; and

WHEREAS, Owner is also authorized to divert not to exceed 90,799 acre-feet of District Return Flows per year from the Trinity River at a maximum rate of 156.5 cfs (70,300 gpm) into an off-channel wetland impoundment with a storage capacity of 2,700 acre-feet for water quality treatment purposes and to subsequently divert and store 88,059 acre-feet of those District Return Flows per year in Cedar Creek Reservoir; and

WHEREAS, TRWD is also authorized to divert and use not to exceed 227,500 acre-feet of water per year from six points on the perimeter of Cedar Creek Reservoir for municipal, mining, industrial and agricultural purposes within TRWD's service area in the Trinity River Basin with not to exceed 52,500 acre-feet of water per year diverted being accounted for as District Return Flows diverted from the Trinity River; and

WHEREAS, multiple diversion rates, priority dates and special conditions apply; and

WHEREAS, TRWD has applied for an amendment to Certificate of Adjudication No. 08-4976 to increase the amount of District Return Flows authorized for diversion from Cedar Creek Reservoir by an additional 35,559 acre-feet of water per year for a total of 88,059 acre-feet per year for municipal, mining, industrial and agricultural purposes within TRWD's service area in the Trinity River Basin; and

WHEREAS, TRWD does not request authorization to divert more water from the reservoir than they are currently authorized to discharge into Cedar Creek Reservoir from the wetlands; and

WHEREAS, the Texas Commission on Environmental Quality (TCEQ or Commission) finds that jurisdiction over the application is established; and

WHEREAS, the Executive Director recommends that special conditions be included in the amendment; and

WHEREAS, one request for a contested case hearing was received for this application and was subsequently withdrawn; and

WHEREAS, the Commission has complied with the requirements of the Texas Water Code and Rules of the Texas Commission on Environmental Quality in issuing this amendment;

NOW, THEREFORE, this amendment to Certificate of Adjudication No. 08-4976, designated Certificate of Adjudication No. 08-4976D, is issued to Tarrant Regional Water District subject to the following terms and conditions:

1. USE

In lieu of thc previous authorization in USE Paragraph 2.B., of Certificate of Adjudication No . 08-4976C to divert and use not to exceed 227,500 acre-feet of water per year from Cedar Creek Reservoir for municipal, mining, industrial and agricultural purposes within TRWD's service area in the Trinity River Basin with not to exceed 52,500 acre-feet of water per year diverted being accounted for as District Return Flows diverted from the Trinity River, Owner is now authorized divert and use not to excccd 263,059 acre-feet of water per year from Cedar Creek Reservoir for municipal, mining, industrial and agricultural purposes within TRWD's service area in the Trinity River Basin with not to exceed 88,059 acre-feet of water per year diverted being accounted for as District Return Flows diverted from the Trinity River.

2. DIVERSION

In addition to the previous authorizations, Owner is authorized to divert the additional 35,559 acre-feet of water per year at those points on Cedar Creek

Reservoir currently authorized by this Certificate.

3. SPECIAL CONDITIONS

a. Owner shall only divert and use water in accordance with the most recently approved *Accounting Plan for the Tarrant Regional Water District's Water Supply*. Owner shall maintain the plan in electronic format and make the data available to the Executive Director upon request. Any modifications to the accounting plan shall be approved by the Executive Director. Any modification to the accounting plan that changes the terms of the certificate must be in the form of an amendment to the certificate. Should Owner fail to maintain the accounting plan or notify the Executive Director of any modifications to the plan, Owner shall immediately cease diversion of water and either apply to amend the certificate, or voluntarily forfeit the amendment. If Owner fails to amend the accounting plan or forfeit the amendment, the Commission may begin proceedings to cancel the amendment. Owner shall immediately notify the Executive Director upon modification of the accounting plan and provide copies of the appropriate documents effectuating such changes.

b. Ninety (90) days prior to the diversion of water for industrial, mining, or agricultural purposes, Owner shall submit to the TCEQ a water conservation plan to comply with Title 30 TAC Chapter 288.

4. CONSERVATION

Owner shall implement water conservation plans that provide for the utilization of those practices, techniques, and technologies that reduce or maintain the consumption of water, prevent or reduce the loss or waste of water, maintain or improve the efficiency in the use of water, increase the recycling and reuse of water, or prevent the pollution of water, so that a water supply is made available for future or alternative uses. Such plans shall include a requirement that in every wholesale water contract entered into on or after the effective date of this amendment, including any contract extension or renewal, that each successive wholesale customer develop and implement conservation measures. If the customer intends to resell the water, then the contract for resale of the water must have water conservation requirements so that each successive wholesale customer in the resale of the water be required to implement water conservation measures.

This amendment is issued subject to all terms, conditions, and provisions contained in Certificate of Adjudication No. 08-4976, as amended, except as specifically amended herein.

This amendment is issued subject to all superior and senior water rights in the Trinity River Basin.

Owner agrees to be bound by the terms, conditions, and provisions contained herein and such agreement is a condition precedent to the granting of this amendment.

All other matters requested in the application which are not specifically granted by this amendment are denied.

This amendment is issued subject to the Rules of the Texas Commission on Environmental Quality and to the right of continuing supervision of State resources exercised by the Commission.

For the Commission

Date Issued: **November 25, 2014**

I, Mary Margaret Wright, County Clerk in and for Henderson County, Texas hereby Certify the above to be a true and correct copy as the same appeas in my office Vol OR Page 916
Record Date of issuance 1-15 2015
By Barbara Cox Deputy.

TRUE AND CORRECT COPY OF ORIGINAL FILED IN HENDERSON COUNTY CLERK'S OFFICE

VOL. 750 PAGE 228

2178

CERTIFICATE OF ADJUDICATION

CERTIFICATE OF ADJUDICATION: 08-5035

OWNER: Tarrant County Water Control and Improvement District No. 1
P. O. Box 4508
Fort Worth, Texas 76106

COUNTIES: Freestone and Navarro

PRIORITY DATE: October 18, 1954

WATERCOURSE: Richland Creek, tributary of the Trinity River

BASIN: Trinity River

WHEREAS, by final decree of the 66th Judicial District Court of Hill County, in Cause No. 28,952 In Re: The Adjudication of Water Rights in the Middle Trinity River Segment of the Trinity River Basin dated September 4, 1986 a right was recognized under Permit 3216 authorizing the Tarrant County Water Control and Improvement District No. 1 to appropriate waters of the State of Texas as set forth below;

NOW, THEREFORE, this certificate of adjudication to appropriate waters of the State of Texas in the Trinity River Basin is issued to the Tarrant County Water Control and Improvement District No. 1, subject to the following terms and conditions:

1. IMPOUNDMENT

Owner is authorized to maintain an existing dam and reservoir on Richland Creek (Richland Creek Reservoir) and impound therein not to exceed 1,135,000 acre-feet of water. The dam is located in the John Thomas Survey, Abstract 603; the Martha Boyd Survey, Abstract 96; the John A. Loyd Survey, Abstract 370; the Florinda Dixon Survey, Abstract 198; the William Lockridge Survey, Abstract 366 in Freestone County and the Garnett G. Cole Survey, Abstract 152 in Navarro County, Texas.

2. USE

Owner is authorized to divert and use not to exceed 210,000 acre-feet of water per annum from Richland Creek Reservoir for municipal purposes.

3. DIVERSION

A. Location
At a point on the perimeter of the aforesaid reservoir in the Julian Fontonoy Survey, Abstract 265, Navarro County, Texas.

B. Maximum rate: 577.78 cfs (260,000 gpm).

4. PRIORITY

The time priority of owner's right is October 18, 1954.

5. SPECIAL CONDITIONS

A. Owner shall maintain a suitable outlet in the aforesaid dam authorized herein to allow the free passage of water that owner is not entitled to divert or impound.

B. Owner shall install and maintain a continuous lake level measuring station for the authorized reservoir and maintain tbe following daily records: (1) Reservoir content; (2) Discharge past the dam; and (3) Diversion for each authorized use. All records shall be compiled monthly and reported to the Commission annually and at other times on request.

C. Owner shall survey and monument an appropriate number of sediment ranges prior to impoundment of water. A set of drawings showing the locations and a profile of each range will be submitted to the Commission along with a revised elevation-area-capacity table based on the surveyed ranges.

D. Fsilure to complete construction of the dam and related facilities within the time limitations established by the Commission shall cause this Certificate of Adjudication to expire and become null and void, unless owners apply for an extension of time to complete construction prior to the deadlines for completion, and the application is subsequently granted. If this certificate of adjudication expires, owner shall thereafter remove the dam in accordance with plans approved by tbe Commission.

E. Priority under this Certificate of Adjudication shall he junior in time to Certificate of Adjudication 08-4992 (October 4, 1959), previously Permit 1948B, (Navarro Mills Reservoir) and Certificate of Adjudication 08-5021 (July 30, 1956), previously Permit 2068, (Bardwell Reservoir).

The locations of pertinent features related to this certificate are shown on Page 20 of the Middle Trinity River Segment Certificates of Adjudication Maps, copies of which are located in the office of the Texas Water Commission, Austin, Texas.

This certificate of adjudication is issued subject to all terms, conditions and provisions in the final decree of the 66th Judicial District Court of Hill County, Texas, in Cause No. 28,952 In Re: The Adjudication of Water Rights in the Middle Trinity River Segment of the Trinity River Basin dated September 4, 1986 and supersedes all rights of the owner asserted in that cause.

Certificate of Adjudication 08-5035

This certificate of adjudication is issued subject to senior and superior water rights in the Trinity River Basin.

This certificate of adjudication is issued subject to the Rules of the Texas Water Commission and its continuing right of supervision of State water resources consistent with the public policy of the State as set forth in the Texas Water Code.

TEXAS WATER COMMISSION

Paul Hopkins

Paul Hopkins, Chairman

DATE ISSUED:

MAY 05 1987

ATTEST:

Mary Ann Hefner

Mary Ann Hefner, Chief Clerk

STATE OF TEXAS
COUNTY OF TRAVIS

I, Mary Ann Hefner, Chief Clerk of the Texas Water Commission, do hereby certify that the foregoing is a true and correct copy of an instrument on file in permanent records of said Commission

Given under my hand and the seal of the Texas Water Commission this the 5th day of May A. D., 1987.

Mary Ann Hefner

Mary Ann Hefner, Chief Clerk

FILED FOR RECORD
At 9:00, o'clock a. M.

MAY 8 1987

DORIS TERRY WELCH
Clerk County Court, Freestone County, Texas
By Doris Terry Welch

01404164

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

THE STATE OF TEXAS
COUNTY OF TRAVIS
I hereby certify that this is a true and correct copy of a Texas Commission on Environmental Quality document which is filed in the permanent records of the Commission
Given under my hand and the seal of office on
Bridget C. Bohac DEC 04 2014
Bridget C. Bohac, Chief Clerk
Texas Commission on Environmental Quality

AMENDMENT TO CERTIFICATE OF ADJUDICATION

CERTIFICATE NO. 08-5035D TYPE: §§11.122

Owner:	Tarrant Regional Water District	Address:	P.O. Box 4508 Fort Worth, Texas 76164
Filed:	October 29, 2013	Granted:	November 25, 2014
Purposes:	Municipal, Mining, Industrial and Agricultural	Counties:	Freestone and Navarro
Watercourse:	Richland Creek, tributary of the Trinity River	Watershed:	Trinity River Basin

WHEREAS, Certificate of Adjudication No. 08-5035 authorizes Tarrant Regional Water District (TRWD or Owner) to maintain an existing dam and reservoir on Richland Creek (Richland-Chambers Reservoir), tributary of the Trinity River, Trinity River Basin and impound not to exceed 1,135,000 acre-feet of water; and

WHEREAS, Owner is also authorized to divert not to exceed 105,019 acre-feet of District Return Flows per year from the Trinity River at a maximum rate of 174.05 cfs (78,110 gpm) into an off-channel wetland impoundment with a storage capacity of 3,000 acre-feet for water quality treatment purposes, and to subsequently divert and store 100,465 acre-feet per year of those District Return Flows in Richland-Chambers Reservoir; and

WHEREAS, TRWD is further authorized to divert and use not to exceed 273,000 acre-feet of water from a point on the perimeter of Richland-Chambers Reservoir for municipal, mining, industrial and agricultural purposes within TRWD's service area in the Trinity River Basin with not to exceed 63,000 acre-feet of water per year diverted being accounted for as District Return Flows diverted from the Trinity River; and

WHEREAS, the Certificate also authorizes the use of the bed and banks of Alligator Creek to convey the District Return Flows to Richland-Chambers Reservoir; and

WHEREAS, multiple diversion rates, priority dates and special conditions apply; and

WHEREAS, TRWD has applied for an amendment to Certificate of Adjudication No. 08-5035 to increase the amount of District Return Flows authorized for diversion from Richland-Chambers Reservoir by an additional 37,465 acre-feet of water per year for a total of 100,465 acre-feet per year for municipal, mining, industrial and agricultural purposes within TRWD's service area in the Trinity River Basin; and

WHEREAS, TRWD does not request authorization to divert more water from the reservoir than they are currently authorized to discharge into Richland-Chambers Reservoir from the wetlands; and

WHEREAS, the Texas Commission on Environmental Quality (TCEQ or Commission) finds that jurisdiction over the application is established; and

WHEREAS, the Executive Director recommends that special conditions be included in the amendment; and

WHEREAS, one request for a contested case hearing was received for this application and was subsequently withdrawn; and

WHEREAS, the Commission has complied with the requirements of the Texas Water Code and Rules of the Texas Commission on Environmental Quality in issuing this amendment;

NOW, THEREFORE, this amendment to Certificate of Adjudication No. 08-5035, designated Certificate of Adjudication No. 08-5035D, is issued to Tarrant Regional Water District subject to the following terms and conditions:

1. USE

In lieu of the previous authorization in USE Paragraph 2.B., of Certificate of Adjudication No. 08-5035C to divert and use not to exceed 273,000 acre-feet of water per year from Richland-Chambers Reservoir for municipal, mining, industrial and agricultural purposes within TRWD's service area in the Trinity River Basin with not to exceed 63,000 acre-feet of water per year diverted being accounted for as District Return Flows diverted from the Trinity River, Owner is now authorized to divert and use not to exceed 310,465 acre-feet of water from Richland-Chambers Reservoir for municipal, mining, industrial and agricultural purposes within TRWD's service area in the Trinity River Basin with not to exceed 100,465 acre-feet of water per year diverted being accounted for as District Return Flows diverted from the Trinity River.

2. DIVERSION

In addition to the previous authorizations, Owner is authorized to divert the additional 37,465 acre-feet of water per year at those points on Richland-Chambers Reservoir currently authorized by this Certificate.

3. SPECIAL CONDITIONS

a. Owner shall only divert and use water in accordance with the most recently approved *Accounting Plan for the Tarrant Regional Water District's Water Supply*. Owner shall maintain the plan in electronic format and make the data available to the Executive Director upon request. Any modifications to the accounting plan shall be approved by the Executive Director. Any modification to the accounting plan that changes the terms of this certificate must be in the form of an amendment to the certificate. Should Owner fail to maintain the accounting plan or notify the Executive Director of any modifications to the plan, Owner shall immediately cease diversion of water and either apply to amend the certificate, or voluntarily forfeit the amendment. If Owner fails to amend the accounting plan or forfeit the amendment, the Commission may begin proceedings to cancel the amendment. Owner shall immediately notify the Executive Director upon modification of the accounting plan and provide copies of the appropriate documents effectuating such changes.

b. Ninety (90) days prior to the diversion of water for industrial, mining, or agricultural purposes, Owner shall submit to the TCEQ a water conservation plan to comply with Title 30 TAC Chapter 288.

4. CONSERVATION

Owner shall implement water conservation plans that provide for the utilization of those practices, techniques, and technologies that reduce or maintain the consumption of water, prevent or reduce the loss or waste of water, maintain or improve the efficiency in the use of water, increase the recycling and reuse of water, or prevent the pollution of water, so that a water supply is made available for future or alternative uses. Such plans shall include a requirement that in every wholesale water contract entered into on or after the effective date of this amendment, including any contract extension or renewal, that each successive wholesale customer develop and implement conservation measures. If the customer intends to resell the water, then the contract for resale of the water must have water conservation requirements so that each successive wholesale customer in the resale of the water be required to implement water conservation measures.

This amendment is issued subject to all terms, conditions, and provisions contained in Certificate of Adjudication No. 08-5035, as amended, except as specifically amended herein.

This amendment is issued subject to all superior and senior water rights in the Trinity River Basin.

Owner agrees to be bound by the terms, conditions, and provisions contained herein and such agreement is a condition precedent to the granting of this amendment.

All other matters requested in the application which are not specifically granted by this amendment are denied.

This amendment is issued subject to the Rules of the Texas Commission on Environmental Quality and to the right of continuing supervision of State resources exercised by the Commission.

For the Commission

Date Issued: **November 25, 2014**

THE STATE OF TEXAS
COUNTY OF FREESTONE
I Linda Jarvis Clerk of the County Court in and for Freestone County, Texas do hereby certify that this instrument was FILED FOR RECORD and RECORDED in the Volume and Page of the Official record and at the time and date stamped before me

County Clerk of Freestone County, Texas

FILED FOR RECORD IN
Freestone County
Lindo Jarvis
COUNTY CLERK
ON: Dec 17,2014 AT 02:55P
as Recordings
Document Number: 014D4164
Total Fees : 38.0D
Receipt Number - 128710
By, Sonomo Adkins, Deputy

(FDD)

STATE OF TEXAS §
§
COUNTY OF TARRANT §

SITE CERTIFICATE

Before me, the undersigned notary, on this day personally appeared **R. Steve Christian**, a person whose identity is known to me or who has presented to me a satisfactory proof of identity. After I administered an oath, this person swore to the following:

(1) My name is **R. Steve Christian.** I am over 18 years of age and I am of sound mind, and capable of swearing to the facts contained in this Site Certificate. The facts stated in this certificate are within my personal knowledge and are true and correct.

(2) I am an authorized representative of **Tarrant Regional Water District**, an entity that has filed an application for financial assistance with the Texas Water Development Board for a water project.

LEGAL CERTIFICATION – OWNERSHIP INTEREST

This is to certify that

Tarrant Regional Water District

has acquired or is in the process of acquiring the necessary real property interest, as evidenced by fee simple purchase or fully executed earnest money contracts, firm option agreements to purchase the subject property or the initiation of eminent domain procedures, that such acquisition will guarantee access and egress and such interest will contain the necessary easements, rights of way or unrestricted use as is required for the project being financed by the Texas Water Development Board. The legal description is referenced below:

The Integrated Pipeline Project spans Tarrant, Johnson, Ellis, Navarro, Henderson, and Anderson Counties. The property interests to be acquired for the project are Fee Simple and Easement estates.

——— Any deeds or other instruments required to be recorded to protect the title(s) held by **Tarrant Regional Water District** have been recorded or filed for the record in the County deed records or other required location.

LEGAL CERTIFICATION – LEASE/CONTRACT

In the alternative, I certify that

N/A

has executed a written lease or other contractual agreement to use the property needed for this (water) (wastewater) project that extends through **2019**, the life of the Texas Water Development Board loan or grant that will be used to finance this project, either in whole or in part. A copy of this lease or agreement is attached hereto.

LEGAL CERTIFICATION – PROPERTY EASEMENT

In the alternative, I certify that

Tarrant Regional Water District

has executed express easements to use the property needed for this water project that extends through **2019**, the life of the Texas Water Development Board loan or grant that will be used to finance this project, either in whole or in part. A copy of the form of express easement agreement is attached hereto.

EXECUTED this 5th day of May, 2015

(Signature)

R. Steve Christian
(Print Name)

Real Property Director
(Title)

Sworn to and subscribed before me by 5th on May, 2015.

RICHARD B. CARROLL NOTARY PUBLIC STATE OF TEXAS [SEAL] 03-27-2016

Notary Public in and for the State of Texas

My Commission expires: 3/27/2016

NOTICE OF CONFIDENTIALITY RIGHTS: IF YOU ARE A NATURAL PERSON, YOU MAY REMOVE OR STRIKE ANY OR ALL OF THE FOLLOWING INFORMATION FROM ANY INSTRUMENT THAT TRANSFERS AN INTEREST IN REAL PROPERTY BEFORE IT IS FILED FOR RECORD IN THE PUBLIC RECORDS: YOUR SOCIAL SECURITY NUMBER OR YOUR DRIVER'S LICENSE NUMBER.

WATER PIPELINE(S) EASEMENT AND RIGHT-OF-WAY

STATE OF TEXAS *

* **KNOW ALL PERSONS BY THESE PRESENTS:**

COUNTY OF _____ *

That _____, a _____, whose address is _____ _____, _____, _____ (herein called "Grantor", whether one or more), for and in consideration of the sum of TEN AND NO/100 DOLLARS ($10.00) and other good and valuable consideration to Grantor in hand paid by TARRANT REGIONAL WATER DISTRICT, a Water Control and Improvement District, a body politic and corporate (herein called "Grantee"), whose mailing address is 800 East North Side Drive, Fort Worth, Texas 76102-1097, the receipt and sufficiency of which are hereby acknowledged, has BARGAINED, SOLD, GRANTED AND CONVEYED, and by these presents does BARGAIN, SELL, GRANT AND CONVEY unto the said Grantee, an easement and right-of-way to survey, perform tests, construct, install, operate, maintain, use, monitor, inspect, alter, relocate, replace, repair, and remove one or more water transportation pipelines (the "Pipeline(s)") and facilities (the "Appurtenant Facilities"), including above-ground and below-ground lines or facilities for electricity and for telephone or other communications or data transmission, water lines, cathodic protection equipment, and such other surface and subsurface equipment and facilities as may be necessary in the judgment of Grantee, in, on, under, over, and across the land described on Exhibit "A" (the "Land") attached hereto and incorporated herein for all purposes. It is expressly stipulated and agreed that multiple Pipelines and Appurtenant Facilities may be constructed, installed, operated, maintained, used, monitored, inspected, altered, relocated, removed, replaced, and repaired in, on, under, over, and across the Land and that such multiple Pipelines and Appurtenant Facilities need not be constructed or installed at the same time. Grantee may at any time construct, install, operate, maintain, use, monitor, inspect, alter, relocate, replace, repair, and remove additional Pipelines and Appurtenant Facilities above, below, or alongside any Pipeline(s) and Appurtenant Facilities constructed or installed in, on, under, over, or across the Land, without additional compensation to Grantor, including compensation for present or future grasses and growing crops disturbed by Grantee's uses of the Land.

The easement and associated rights granted hereby are sometimes collectively hereinafter referred to as the "Easement."

Grantee agrees and covenants that the Pipeline(s) will be buried so that the top(s) of said Pipeline(s) will be a minimum of forty inches (40") below the surface of the Land.

There is reserved from this conveyance and retained by Grantor all of the groundwater and all of the oil, gas, sulphur, and other gaseous minerals in, on or under the Land, but Grantor waives all rights of ingress and egress to or from the surface of the Land for the purposes of exploring, developing, mining, or drilling therefor; it being specifically agreed that no operations relating to such reservation will be conducted on the surface of the Land without Grantee's prior written permission. Grantor reserves the right to explore for, develop, and produce groundwater and minerals that may be produced through a wellbore provided that such water or minerals are produced by directional drilling or other means that do not require use of the surface of the Land and provided that such activities do not impact the lateral or subjacent support for the Pipeline(s) and Appurtenant Facilities or otherwise adversely impact the Easement granted hereby.

Grantee shall have full and unlimited access at all times along, upon, over, and through the Land for the purpose of surveying, performing tests, constructing, installing, maintaining, using, monitoring, operating, inspecting, altering, replacing, repairing, relocating, or removing Pipeline(s) and Appurtenant Facilities, including the right to patrol the Land on foot, with vehicles, and with aircraft. Grantee may cross fences, open gates, and reasonably traverse adjacent property as part of this access. If a pond, stock tank, creek, stream, freshet or other improvement or watercourse encroaches upon or exists or drains on the Land, Grantee shall have the right to remove, fill, redirect or otherwise remediate the impacts of any such improvement or condition, including by installing laterals, ditches or other facilities to direct or redirect water flows across the Land and shall have the right to enter upon and perform such activities on the adjacent lands of Grantor. Grantee shall also have the right to excavate, remove from the Land, and, at its option, replace soil, timber, gravel, rocks, and other materials and facilities found in, on, upon, or under the Land, and the consideration paid to Grantor includes all damages arising therefrom.

Grantor agrees not to erect, place, or permit any buildings, structures, or other improvements or obstructions on, in, or over the Land. Grantor shall make no commercial use of the Land except for agricultural uses permitted hereby. Grantor shall not conduct or allow any surface activity within a five (5) foot radius of any above-ground Appurtenant Facility. Grantor may use the Land for growing crops, provided that any such cultivation is no more than two (2) feet deep, and no cultivation may take place within a ten (10) foot radius of any above-ground Appurtenant Facility. Grantee has the right to remove any trees, woody plants, brush, and nursery stock planted or existing on the Land without liability therefor. Grantor may use the surface of the Land for grazing of livestock, provided that no livestock may be penned or concentrated on the Easement. Notwithstanding the foregoing, Grantor will not import to or otherwise cause to remain on or in close proximity to the Land any species designated as threatened or endangered or that is otherwise protected under the Endangered Species Act of 1973, as amended, or any similar or related Texas or federal law. With the prior written approval of Grantee, Grantor may use the surface of the Land for roads, paving, and for vehicular, pedestrian, and livestock ingress and egress so long as any such improvements and activities cross the Land at angles of approximately ninety (90) degrees, do not violate any applicable law, rule, regulation, or specification (including maximum surface loading limitations on the Pipeline(s) or Appurtenant Facilities), or endanger or interfere with the safety, efficiency, or convenient surveying, performance of tests, construction, installation, inspection, alteration, relocation, replacement, operation, repair, removal, or maintenance of the Pipeline(s) and Appurtenant Facilities or any other right of Grantee hereunder. Heavy loads exceeding the maximum surface loading limitations as provided by American Association of State Highway & Transportation Officials specification HS20 (16,000 pounds per wheel; 32,000 pounds per axle) may not be driven or otherwise transported on the Land on top of or parallel to the Pipeline(s) or Appurtenant Facilities without the prior written permission of Grantee. Grantor may place or allow the placement of below-ground utility lines for the purpose of providing utility service to the adjacent lands of Grantor so long as such line(s) do not run parallel to the Pipeline(s), cross the Pipeline(s) at an angle of approximately ninety (90) degrees, maintain at least a two-foot vertical separation from the Pipeline(s) and Appurtenant Facilities, and are buried and otherwise constructed in such a manner as to fully comply with all applicable rules, regulations, ordinances and laws, including, without limitation, casing and separation requirements imposed by the Texas Administrative Code, as amended, and so as not to endanger the Pipeline(s) or Appurtenant Facilities or otherwise interfere with the rights of Grantee hereunder. Grantor shall not take or permit any action that damages or endangers the Pipeline(s) or Appurtenant Facilities or the lateral or subjacent support therefor. Any prohibited use or installation on, over, or under the Land by or for Grantor will be removed by Grantee at Grantor's sole cost and expense, and Grantee shall have no liability arising therefrom.

Prior to the commencement of construction or the placement of anything in, upon, on, or under the Land, Grantor shall submit written plans therefor to Grantee, fully describing such proposed placement or construction and demonstrating, to Grantee's satisfaction, that such plans comply with the terms hereof and all applicable rules, regulations, and laws. No such placement or construction in, on, or under the Land shall commence until such plans have been approved in writing by Grantee to comply with the terms hereof and all applicable rules, regulations, ordinances, and laws. Grantor shall not excavate, remove, or place soil or other materials on or in the Land, or

otherwise change the surface contour thereof, without the prior written permission of Grantee. Grantor shall not install fencing on or across the Land without the written approval of Grantee, and Grantor agrees that any approved fencing will incorporate a gate (to be supplied by Grantee at its expense upon request by Grantor) of a size, design, and in a location determined by Grantee. Any such gate shall remain unblocked so as to allow Grantee access to the Land at all times. If any such gate requires a lock, Grantor agrees to coordinate with Grantee so that Grantee is allowed access to the Land at any and all times; Grantee may cut, remove, and replace locks which prevent Grantee from exercising its rights hereunder. Grantee shall have the right to construct a road across the Land to access the Pipeline(s) and Appurtenant Facilities for maintenance and other purposes. Grantor shall not use the Land for any type of storage, including the placement of automobiles or equipment on or in the Land. Grantor shall not use the Land for wastewater treatment or disposal. Grantor shall not construct any improvements for the diversion or impoundment of water, such as, but not limited to, wells, wetlands, ponds, canals, ditches or reservoirs in, upon, or over the Land. Grantor shall not include the Land within the boundaries of any platted lot that includes other land. Any plat of the Land as a separate lot must be approved in writing by Grantee. Grantor shall not tap into, connect with, or otherwise access the Pipeline(s) or Appurtenant Facilities.

Subject to the foregoing, Grantor shall have the right, subordinate to the rights of Grantee created hereby, to subject the Land to any use deemed desirable by Grantor so long as such use does not restrict the use of the Land, Easement, and appurtenant rights by Grantee and complies with the restrictions on Grantor's use set forth hereinabove.

It is understood that Grantee is acquiring the Easement for the purposes of constructing, installing, maintaining, using, monitoring, and operating the Pipeline(s) and Appurtenant Facilities for public purposes and uses, and that this negotiated sale is made in lieu of condemnation proceedings at law. The consideration paid to Grantor hereunder shall include and cover all claims and damages which Grantor could have asserted in condemnation proceedings, including damages to any adjoining property owned by Grantor and damages to the surface, including, but not limited to, grasses and growing crops, and includes compensation for the installation of Pipeline(s) and Appurtenant Facilities which Grantee may elect to install after the initial installation of Pipeline(s) or Appurtenant Facilities. It is expressly understood and agreed that Grantor shall be solely responsible for any claims of damages now or in the future by any grazing or agricultural tenant or others person claiming by, through or under Grantor. Grantee shall not be liable for any damages resulting from keeping the Land clear of trees, brush, undergrowth, and other obstructions in the course of surveying, performance of tests, constructing, operating, maintaining, using, monitoring, inspecting, altering, relocating, replacing, repairing, or removing the Pipeline(s) and Appurtenant Facilities.

TO HAVE AND TO HOLD the above-described Easement, together with all and singular the rights and appurtenances thereto in anywise belonging, to the Grantee, its successors and assigns, forever. Grantor does hereby bind Grantor, and Grantor's heirs, executors, administrators and assigns, to WARRANT AND FOREVER DEFEND all and singular the said Easements unto the Grantee, the said Tarrant Regional Water District, its successors and assigns, against every person whomsoever lawfully claiming or to claim the same or any part thereof, by, through, or under Grantor, but not otherwise, and subject to all matters of record.

The terms and provisions hereof shall inure to the benefit of and be binding upon Grantor and Grantee, and their respective heirs, executors, administrators, legal representatives, agents, servants, employees, contractors, successors and assigns, and shall be covenants running with the land. Nothing contained herein shall be construed to make Grantor and Grantee partners or joint venturers or to render either party liable for any obligation of the other.

This grant covers all of the agreements between the parties, and no prior representations or statements, verbal or written, have been made modifying, adding to, or changing the terms of this agreement. No amendments, modifications or revisions hereof shall be effective unless made in writing and signed by the parties hereto. This Water Pipeline(s) Easement and Right-of-Way shall be construed and enforced in accordance with the laws of the

State of Texas. Grantee, at its election, may record this instrument or may prepare, execute, and record a memorandum of same. Grantor will execute and acknowledge any such memorandum at Grantee's request.

The person executing this instrument on behalf of Grantor warrants and represents that he/she is duly authorized to execute and deliver this instrument on behalf of Grantor, and that same is the valid act and deed of Grantor, enforceable according to its terms.

EXECUTED this _____ day of _____, 20___.

_____,
a _____

By:_____
Its:_____

TARRANT REGIONAL WATER DISTRICT, a
Water Control and Improvement District

By: _____
R. Steve Christian
Real Property Director

STATE OF TEXAS *
*
COUNTY OF _____ *

This instrument was acknowledged before me on this _____ day of _____, 20___, by _____, the _____ of, a _____, on behalf of said _____.

_____
Notary Public for the State of Texas

STATE OF TEXAS *
*
COUNTY OF TARRANT *

The foregoing instrument was acknowledged before me on this _____ day of _____, 20___, by R. Steve Christian, Real Property Director of Tarrant Regional Water District, a Water Control and Improvement District, on behalf of said District.

_____
Notary Public for the State of Texas

AFTER RECORDING, RETURN TO:

Tarrant Regional Water District
P.O. Box 4508
Fort Worth, Texas 76164-0508
Attn: Mr. R. Steve Christian

P: TRWD Palestine Connection Easement Easement (3-7-11 Clean)

DEPARTMENT OF THE ARMY
FORT WORTH DISTRICT, CORPS OF ENGINEERS
P.O. BOX 17300
FORT WORTH, TEXAS 76102-0300

REPLY TO
ATTENTION OF

September 17, 2013

Planning, Environmental, and Regulatory Division
Regulatory Branch

SUBJECT: Projeet Number SWF-2011-00074, Intcgrated Pipeline Projcct

Mr. Woody Frossard
Tarrant Regional Water District
800 East Northside Drive
Fort Worth, Texas 76102

Dear Mr. Frossard:

Thank you for your letter receivcd May 22, 2013, and subsequent submittals received May 28, 2013, July 31, 2013, and August 5, 2013, concerning a proposal by the Tarrant Regional Water Distriet to construct approximately 93 miles of 84- to 108-inch pipelinc, from Cedar Creek and Richland Chambers Reservoirs westward to the Kennedale Balancing Reservoir starting in Henderson and Navarro Counties and crossing Ellis, Johnson, and Tarrant Counties, Texas. This project has been assigned Project Number SWF-2011-00074. Please include this number in all future eorrespondence concerning this project.

Under Section 404 of the Clean Water Act the U. S. Army Corps of Engineers (USACE) regulates the discharge of dredged and fill material into waters of the United States, including wetlands. USACE responsibility under Section 10 of thc Rivers and Harbors Act of 1899 is to regulate any work in, or affecting, navigable waters of thc United States. Based on your description of the proposed work, and other information available to us, we havc determined this projcct will involve activities subject to the requirements of Scetion 404 and Scction 10. The USACE based this decision on a preliminary jurisdictional determination that there are waters of the United States on the project site.

We have reviewed this project under the pre-construction notification procedures of Nationwide Permit General Condition 31 (Federal Register, Vol. 77, No. 34, Tuesday, February 21, 2012). We havc determined this project is authorized by Nationwide Permit 12 for Utility Line Activities. To usc this permit, the person responsible for the project must ensure the work is in compliance with the specifications and conditions listed on the enclosures and the speeial conditions listed below.

1. The permittee understands and agrees that, if future operations by the United States require the removal, relocation, or other alteration, of the structure or work herein authorized, or if, in the opinion of the Secretary of the Army or his authorized representative, said structure or work shall cause unreasonable obstruction to the free navigation of the navigable waters, the permittee will be required, upon due notice from the Corps of Engineers, to remove, relocate, or alter the structural work or obstructions caused thereby, without expense to the United States. No claim shall be made against the United States on account of any such removal or alteration.

2. The permittee shall implement and abide by the mitigation plan included in the "IPL Project – Preconstruction Notification," prepared by Freese and Nichols, Inc., dated May 2013. The permittee shall implement the mitigation plan concurrently with the construction of the project. Completion of all elements of this mitigation plan is a requirement of this permit.

3. The permittee shall implement and abide hy invasive species controls included in the "Integrated Pipeline Project, IPL, Management of Invasive Species Study, Final Report," prepared by CH2MHill., dated August 2013.

4. The permittee shall not initiate any construction for this undertaking that will affect any identified historic property eligible, or potentially eligible for listing, in the National Register of Historic Places (NRHP) until the USACE has verified the requirements of 33 CFR 325 (Appendix C) and 36 CFR 800. After assessment by the USACE, additional work to protect, avoid, or mitigate impacts to historic properties may be necessary. If a previously unknown cultural resource site is encountered during work authorized by this permit, the permittee shall immediately contact the USACE and avoid further impact to the site until assessment, and the requirements for any additional work, are determined.

Failure to comply with these specifications and conditions invalidates the authorization and may result in a violation.

Our verification for the construction of this activity under this nationwide permit is valid until March 18, 2017, unless prior to that date the nationwide permit is suspended, revoked, or modified such that the activity would no longer comply with the terms and conditions of the nationwide permit on a regional or national basis. The USACE will issue a public notice announcing the changes when they occur. Furthermore, activities that have commenced, or are under contract to commence, in reliance on a nationwide permit will remain authorized provided the activity is completed within 12 months of the date of the nationwide permit's expiration, modification, or revocation, unless discretionary authority has heen exercised on a case-by-case basis to modify, suspend, or revoke the authorization in accordance with 33 CFR 330.4(e) and 33 CFR 330.5(c) or (d).

Our review of this project also addressed its effects on threatened and endangered species. Based on the information provided, we have determined this project will not affect any species listed as threatened or endangered by the U.S. Fish and Wildlife Service within our permit area. However, please note you are responsible for meeting the requirements of General Condition 18 on endangered species.

The permittee must sign and submit to us the enclosed certification that the work, including any proposed mitigation, was completed in compliance with the nationwide permit. The permittee should submit the certification within 30 days of the completion of work.

This permit should not be considered as an approval of the design features of any activity authorized or an implication that such construction is considered adequate for the purpose intended. It does not authorize any damage to private property, invasion of property rights, or any infringement of federal, state, or local laws or regulations.

Thank you for your interest in our nation's water resources. If you have any questions concerning our regulatory program, please refer to our website at http://www.swf.usace.army.mil/Missions/Regulatory.aspx or contact Mr. Frederick Land at the address above or telephone (817) 886-1729.

Please help the Regulatory Program improve its service by completing the survey on the following website: http://per2.nwp.usace.army.mil/survey.html.

Sincerely,

Stephen L Brooks
Chief, Regulatory Branch

Enclosures

Copy Furnish:

Mr. Steve Watters
Freese and Nichols, Inc.
4055 International Plaza, Suite 200
Fort Worth, Texas 76109

NATIONWIDE PERMIT 12

Utility Line Activities

Effective Date: March 19, 2012

(NWP Final Notice, 77 FR 10184)

Utility Line Activities. Activities required for the construction, maintenance, repair, and removal of utility lines and associated facilities in waters of the United States, provided the activity does not result in the loss of greater than 1/2-acre of waters of the United States for each single and complete project.

Utility lines: This NWP authorizes the construction, maintenance, or repair of utility lines, including outfall and intake structures, and the associated excavation, backfill, or bedding for the utility lines, in all waters of the United States, provided there is no change in pre-construction contours. A "utility line" is defined as any pipe or pipeline for the transportation of any gaseous, liquid, liquescent, or slurry substance, for any purpose, and any cable, line, or wire for the transmission for any purpose of electrical energy, telephone, and telegraph messages, and radio and television communication. The term "utility line" does not include activities that drain a water of the United States, such as drainage tile or french drains, but it does apply to pipes conveying drainage from another area.

Material resulting from trench excavation may be temporarily sidecast into waters of the United States for no more than three months, provided the material is not placed in such a manner that it is dispersed by currents or other forces. The district engineer may extend the period of temporary side casting for no more than a total of 180 days, where appropriate. In wetlands, the top 6 to 12 inches of the trench should normally be backfilled with topsoil from the trench. The trench cannot be constructed or backfilled in such a manner as to drain waters of the United States (e.g., backfilling with extensive gravel layers, creating a french drain effect). Any exposed slopes and stream banks must be stabilized immediately upon completion of the utility line crossing of each waterbody.

Utility line substations: This NWP authorizes the construction, maintenance, or expansion of substation facilities associated with a power line or utility line in non-tidal waters of the United States, provided the activity, in combination with all other activities included in one single and complete project, does not result in the loss of greater than 1/2-acre of waters of the United States. This NWP does not authorize discharges into non-tidal wetlands adjacent to tidal waters of the United States to construct, maintain, or expand substation facilities.

Foundations for overhead utility line towers, poles, and anchors: This NWP authorizes the construction or maintenance of foundations for overhead utility line towers, poles, and anchors in all waters of the United States, provided the foundations are the minimum size necessary and separate footings for each tower leg (rather than a larger single pad) are used where feasible.

Access roads: This NWP authorizes the construction of access roads for the construction and maintenance of utility lines, including overhead power lines and utility line substations, in non-tidal waters of the United States, provided the activity, in combination with all other activities included in one single and complete project, does not cause the loss of greater than 1/2-acre of non-tidal waters of the United States. This NWP does not authorize discharges into non-tidal wetlands adjacent to tidal waters for access roads. Access roads must be the minimum width necessary (see Note 2, below). Access roads must be constructed so that the length of the road minimizes any adverse effects on waters of the United States and must be as near as possible to pre-construction contours and elevations (e.g., at grade corduroy roads or geotextile/gravel

roads). Access roads constructed above pre-construction contours and elevations in waters of the United States must be properly bridged or culverted to maintain surface flows.

This NWP may authorize utility lines in or affecting navigable waters of the United States even if there is no associated discharge of dredged or fill material (See 33 CFR Part 322). Overhead utility lines constructed over section 10 waters and utility lines that are routed in or under section 10 waters without a discharge of dredged or fill material require a section 10 permit.

This NWP also authorizes temporary structures, fills, and work necessary to conduct the utility line activity. Appropriate measures must be taken to maintain normal downstream flows and minimize flooding to the maximum extent practicable, when temporary structures, work, and discharges, including cofferdams, are necessary for construction activities, access fills, or dewatering of construction sites. Temporary fills must consist of materials, and be placed in a manner, that will not be eroded by expected high flows. Temporary fills must be removed in their entirety and the affected areas returned to pre-construction elevations. The areas affected by temporary fills must be revegetated, as appropriate.

Notification: The permittee must submit a pre-construction notification to the district engineer prior to commencing the activity if any of the following criteria are met: (1) the activity involves mechanized land clearing in a forested wetland for the utility line right-of-way; (2) a section 10 permit is required; (3) the utility line in waters of the United States, excluding overhead lines, exceeds 500 feet; (4) the utility line is placed within a jurisdictional area (i.e., water of the United States), and it runs parallel to or along a stream bed that is within that jurisdictional area; (5) discharges that result in the loss of greater than 1/10-acre of waters of the United States; (6) permanent access roads are constructed above grade in waters of the United States for a distance of more than 500 feet; or (7) permanent access roads are constructed in waters of the United States with impervious materials. (See general condition 31.) (Sections 10 and 404)

Note 1: Where the proposed utility line is constructed or installed in navigable waters of the United States (i.e., section 10 waters) within the coastal United States, the Great Lakes, and United States territories, copies of the pre-construction notification and NWP verification will be sent by the Corps to the National Oceanic and Atmospheric Administration (NOAA), National Ocean Service (NOS), for charting the utility line to protect navigation.

Note 2: Access roads used for both construction and maintenance may be authorized, provided they meet the terms and conditions of this NWP. Access roads used solely for construction of the utility line must be removed upon completion of the work, in accordance with the requirements for temporary fills.

Note 3: Pipes or pipelines used to transport gaseous, liquid, liquescent, or slurry substances over navigable waters of the United States are considered to be bridges, not utility lines, and may require a permit from the U.S. Coast Guard pursuant to Section 9 of the Rivers and Harbors Act of 1899. However, any discharges of dredged or fill material into waters of the United States associated with such pipelines will require a section 404 permit (see NWP 15).

Note 4: For overhead utility lines authorized by this NWP, a copy of the PCN and NWP verification will be provided to the Department of Defense Siting Clearinghouse, which will evaluate potential effects on military activities.

Nationwide Permit General Conditions

Note: To qualify for NWP authorization, the prospective permittee must comply with the following general conditions, as applicable, in addition to any regional or case-specific conditions imposed by the division engineer or district engineer. Prospective permittees should contact the appropriate Corps district office to determine if regional conditions have been imposed on an NWP. Prospective permittees should also contact the appropriate Corps district office to determine the status of Clean Water Act Section 401 water quality certification and/or Coastal Zone Management Act consistency for an NWP. Every person who may wish to obtain permit authorization under one or more NWPs, or who is currently relying on an existing or prior permit authorization under one or more NWPs, has been and is on notice that all of the provisions of 33 CFR §§ 330.1 through 330.6 apply to every NWP authorization. Note especially 33 CFR § 330.5 relating to the modification, suspension, or revocation of any NWP authorization.

1. Navigation. (a) No activity may cause more than a minimal adverse effect on navigation.

(b) Any safety lights and signals prescribed by the U.S. Coast Guard, through regulations or otherwise, must be installed and maintained at the permittee's expense on authorized facilities in navigable waters of the United States.

(c) The permittee understands and agrees that, if future operations by the United States require the removal, relocation, or other alteration, of the structure or work herein authorized, or if, in the opinion of the Secretary of the Army or his authorized representative, said structure or work shall cause unreasonable obstruction to the free navigation of the navigable waters, the permittee will be required, upon due notice from the Corps of Engineers, to remove, relocate, or alter the structural work or obstructions caused thereby, without expense to the United States. No claim shall be made against the United States on account of any such removal or alteration.

2. Aquatic Life Movements. No activity may substantially disrupt the necessary life cycle movements of those species of aquatic life indigenous to the waterbody, including those species that normally migrate through the area, unless the activity's primary purpose is to impound water. All permanent and temporary crossings of waterbodies shall be suitably culverted, bridged, or otherwise designed and constructed to maintain low flows to sustain the movement of those aquatic species.

3. Spawning Areas. Activities in spawning areas during spawning seasons must be avoided to the maximum extent practicable. Activities that result in the physical destruction (e.g., through excavation, fill, or downstream smothering by substantial turbidity) of an important spawning area are not authorized.

4. Migratory Bird Breeding Areas. Activities in waters of the United States that serve as breeding areas for migratory birds must be avoided to the maximum extent practicable.

5. Shellfish Beds. No activity may occur in areas of concentrated shellfish populations, unless the activity is directly related to a shellfish harvesting activity authorized by NWPs 4 and 48, or is a shellfish seeding or habitat restoration activity authorized by NWP 27.

6. Suitable Material. No activity may use unsuitable material (e.g., trash, debris, car bodies, asphalt, etc.). Material used for construction or discharged must be free from toxic pollutants in toxic amounts (see Section 307 of the Clean Water Act).

7. Water Supply Intakes. No activity may occur in the proximity of a public water supply intake, except where the activity is for the repair or improvement of public water supply intake structures or adjacent bank stabilization.

8. Adverse Effects From Impoundments. If the activity creates an impoundment of water, adverse effects to the aquatic system due to accelerating the passage of water, and/or restricting its flow must be minimized to the maximum extent practicable.

9. Management of Water Flows. To the maximum extent practicable, the pre-construction course, condition, capacity, and location of open waters must be maintained for each activity, including stream channelization and storm water management activities, except as provided below. The activity must be constructed to withstand expected high flows. The activity must not restrict or impede the passage of normal or high flows, unless the primary purpose of the activity is to impound water or manage high flows. The activity may alter the pre-construction course, condition, capacity, and location of open waters if it benefits the aquatic environment (e.g., stream restoration or relocation activities).

10. Fills Within 100-Year Floodplains. The activity must comply with applicable FEMA-approved state or local floodplain management requirements.

11. Equipment. Heavy equipment working in wetlands or mudflats must be placed on mats, or other measures must be taken to minimize soil disturbance.

12. Soil Erosion and Sediment Controls. Appropriate soil erosion and sediment controls must be used and maintained in effective operating condition during construction, and all exposed soil and other fills, as well as any work below the ordinary high water mark or high tide line, must be permanently stabilized at the earliest practicable date. Permittees are encouraged to perform work within waters of the United States during periods of low-flow or no-flow.

13. Removal of Temporary Fills. Temporary fills must be removed in their entirety and the affected areas returned to pre-construction elevations. The affected areas must be revegetated, as appropriate.

14. Proper Maintenance. Any authorized structure or fill shall be properly maintained, including maintenance to ensure public safety and compliance with applicable NWP general conditions, as well as any activity-specific conditions added by the district engineer to an NWP authorization.

15. Single and Complete Project. The activity must be a single and complete project. The same NWP cannot be used more than once for the same single and complete project.

16. Wild and Scenic Rivers. No activity may occur in a component of the National Wild and Scenic River System, or in a river officially designated by Congress as a "study river" for possible inclusion in the system while the river is in an official study status, unless the appropriate Federal agency with direct management responsibility for such river, has determined in writing that the proposed activity will not adversely affect the Wild and Scenic River designation or study status. Information on Wild and Scenic Rivers may be obtained from the appropriate Federal land management agency responsible for the designated Wild and Scenic River or study river (e.g., National Park Service, U.S. Forest Service, Bureau of Land Management, U.S. Fish and Wildlife Service).

17. Tribal Rights. No activity or its operation may impair reserved tribal rights, including, but not limited to, reserved water rights and treaty fishing and hunting rights.

18. Endangered Species. (a) No activity is authorized under any NWP which is likely to directly or indirectly jeopardize the continued existence of a threatened or endangered species or a species proposed for such designation, as identified under the Federal Endangered Species Act (ESA), or which will directly or indirectly destroy or adversely modify the critical habitat of such species. No activity is authorized under any NWP which "may affect" a listed species or critical habitat, unless Section 7 consultation addressing the effects of the proposed activity has been completed.

(b) Federal agencies should follow their own procedures for complying with the requirements of the ESA. Federal permittees must provide the district engineer with the appropriate documentation to demonstrate compliance with those requirements. The district engineer will review the documentation and determine whether it is sufficient to address ESA compliance for the NWP activity, or whether additional ESA consultation is necessary.

(c) Non-federal permittees must submit a pre-construction notification to the district engineer if any listed species or designated critical habitat might be affected or is in the vicinity of the project, or if the project is located in designated critical habitat, and shall not begin work on the activity until notified by the district engineer that the requirements of the ESA have been satisfied and that the activity is authorized. For activities that might affect Federally-listed endangered or threatened species or designated critical habitat, the pre-construction notification must include the name(s) of the endangered or threatened species that might be affected by the proposed work or that utilize the designated critical habitat that might be affected by the proposed work. The district engineer will determine whether the proposed activity "may affect" or will have "no effect" to listed species and designated critical habitat and will notify the non-Federal applicant of the Corps' determination within 45 days of receipt of a complete pre-construction notification. In cases where the non-Federal applicant has identified listed species or critical habitat that might be affected or is in the vicinity of the project, and has so notified the Corps, the applicant shall not begin work until the Corps has provided notification the proposed activities will have "no effect" on listed species or critical habitat, or until Section 7 consultation has been completed. If the non-Federal applicant has not heard back from the Corps within 45 days, the applicant must still wait for notification from the Corps.

(d) As a result of formal or informal consultation with the FWS or NMFS the district engineer may add species-specific regional endangered species conditions to the NWPs.

(e) Authorization of an activity by a NWP does not authorize the "take" of a threatened or endangered species as defined under the ESA. In the absence of separate authorization (e.g., an

ESA Section 10 Permit, a Biological Opinion with “incidental take” provisions, etc.) from the U.S. FWS or the NMFS, The Endangered Species Act prohibits any person subject to the jurisdiction of the United States to take a listed species, where "take" means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. The word “harm” in the definition of “take" means an act which actually kills or injures wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering.

(f) Information on the location of threatened and endangered species and their critical habitat can be obtained directly from the offices of the U.S. FWS and NMFS or their world wide web pages at http://www.fws.gov/ or http://www.fws.gov/ipac and http://www.noaa.gov/fisheries.html respectively.

19. Migratory Birds and Bald and Golden Eagles. The permittee is responsible for obtaining any “take” permits required under the U.S. Fish and Wildlife Service’s regulations governing compliance with the Migratory Bird Treaty Act or the Bald and Golden Eagle Protection Act. The permittee should contact the appropriate local office of the U.S. Fish and Wildlife Service to determine if such “take” permits are required for a particular activity.

20. Historic Properties. (a) In cases where the district engineer determines that the activity may affect properties listed, or eligible for listing, in the National Register of Historic Places, the activity is not authorized, until the requirements of Section 106 of the National Historic Preservation Act (NHPA) have been satisfied.

(b) Federal permittees should follow their own procedures for complying with the requirements of Section 106 of the National Historic Preservation Act. Federal permittees must provide the district engineer with the appropriate documentation to demonstrate compliance with those requirements. The district engineer will review the documentation and determine whether it is sufficient to address section 106 compliance for the NWP activity, or whether additional section 106 consultation is necessary.

(c) Non-federal permittees must submit a pre-construction notification to the district engineer if the authorized activity may have the potential to cause effects to any historic properties listed on, determined to be eligible for listing on, or potentially eligible for listing on the National Register of Historic Places, including previously unidentified properties. For such activities, the pre-construction notification must state which historic properties may be affected by the proposed work or include a vicinity map indicating the location of the historic properties or the potential for the presence of historic properties. Assistance regarding information on the location of or potential for the presence of historic resources can be sought from the State Historic Preservation Officer or Tribal Historic Preservation Officer, as appropriate, and the National Register of Historic Places (see 33 CFR 330.4(g)). When reviewing pre-construction notifications, district engineers will comply with the current procedures for addressing the requirements of Section 106 of the National Historic Preservation Act. The district engineer shall make a reasonable and good faith effort to carry out appropriate identification efforts, which may include background research, consultation, oral history interviews, sample field investigation, and field survey. Based on the information submitted and these efforts, the district engineer shall determine whether the proposed activity has the potential to cause an effect on the historic properties. Where the non-Federal applicant has identified historic properties on which the

activity may have the potential to cause effects and so notified the Corps, the non-Federal applicant shall not begin the activity until notified by the district engineer either that the activity has no potential to cause effects or that consultation under Section 106 of the NHPA has been completed.

(d) The district engineer will notify the prospective permittee within 45 days of receipt of a complete pre-construction notification whether NHPA Section 106 consultation is required. Section 106 consultation is not required when the Corps determines that the activity does not have the potential to cause effects on historic properties (see 36 CFR §800.3(a)). If NHPA section 106 consultation is required and will occur, the district engineer will notify the non-Federal applicant that he or she cannot begin work until Section 106 consultation is completed. If the non-Federal applicant has not heard back from the Corps within 45 days, the applicant must still wait for notification from the Corps.

(e) Prospective permittees should be aware that section 110k of the NHPA (16 U.S.C. 470h-2(k)) prevents the Corps from granting a permit or other assistance to an applicant who, with intent to avoid the requirements of Section 106 of the NHPA, has intentionally significantly adversely affected a historic property to which the permit would relate, or having legal power to prevent it, allowed such significant adverse effect to occur, unless the Corps, after consultation with the Advisory Council on Historic Preservation (ACHP), determines that circumstances justify granting such assistance despite the adverse effect created or permitted by the applicant. If circumstances justify granting the assistance, the Corps is required to notify the ACHP and provide documentation specifying the circumstances, the degree of damage to the integrity of any historic properties affected, and proposed mitigation. This documentation must include any views obtained from the applicant, SHPO/THPO, appropriate Indian tribes if the undertaking occurs on or affects historic properties on tribal lands or affects properties of interest to those tribes, and other parties known to have a legitimate interest in the impacts to the permitted activity on historic properties.

21. Discovery of Previously Unknown Remains and Artifacts. If you discover any previously unknown historic, cultural or archeological remains and artifacts while accomplishing the activity authorized by this permit, you must immediately notify the district engineer of what you have found, and to the maximum extent practicable, avoid construction activities that may affect the remains and artifacts until the required coordination has been completed. The district engineer will initiate the Federal, Tribal and state coordination required to determine if the items or remains warrant a recovery effort or if the site is eligible for listing in the National Register of Historic Places.

22. Designated Critical Resource Waters. Critical resource waters include, NOAA-managed marine sanctuaries and marine monuments, and National Estuarine Research Reserves. The district engineer may designate, after notice and opportunity for public comment, additional waters officially designated by a state as having particular environmental or ecological significance, such as outstanding national resource waters or state natural heritage sites. The district engineer may also designate additional critical resource waters after notice and opportunity for public comment.

(a) Discharges of dredged or fill material into waters of the United States are not authorized by NWPs 7, 12, 14, 16, 17, 21, 29, 31, 35, 39, 40, 42, 43, 44, 49, 50, 51, and 52 for

any activity within, or directly affecting, critical resource waters, including wetlands adjacent to such waters.

(b) For NWPs 3, 8, 10, 13, 15, 18, 19, 22, 23, 25, 27, 28, 30, 33, 34, 36, 37, and 38, notification is required in accordance with general condition 31, for any activity proposed in the designated critical resource waters including wetlands adjacent to those waters. The district engineer may authorize activities under these NWPs only after it is determined that the impacts to the critical resource waters will be no more than minimal.

23. Mitigation. The district engineer will consider the following factors when determining appropriate and practicable mitigation necessary to ensure that adverse effects on the aquatic environment are minimal:

(a) The activity must be designed and constructed to avoid and minimize adverse effects, both temporary and permanent, to waters of the United States to the maximum extent practicable at the project site (i.e., on site).

(b) Mitigation in all its forms (avoiding, minimizing, rectifying, reducing, or compensating for resource losses) will be required to the extent necessary to ensure that the adverse effects to the aquatic environment are minimal.

(c) Compensatory mitigation at a minimum one-for-one ratio will be required for all wetland losses that exceed 1/10-acre and require pre-construction notification, unless the district engineer determines in writing that either some other form of mitigation would be more environmentally appropriate or the adverse effects of the proposed activity are minimal, and provides a project-specific waiver of this requirement. For wetland losses of 1/10-acre or less that require pre-construction notification, the district engineer may determine on a case-by-case basis that compensatory mitigation is required to ensure that the activity results in minimal adverse effects on the aquatic environment. Compensatory mitigation projects provided to offset losses of aquatic resources must comply with the applicable provisions of 33 CFR part 332.

(1) The prospective permittee is responsible for proposing an appropriate compensatory mitigation option if compensatory mitigation is necessary to ensure that the activity results in minimal adverse effects on the aquatic environment.

(2) Since the likelihood of success is greater and the impacts to potentially valuable uplands are reduced, wetland restoration should be the first compensatory mitigation option considered.

(3) If permittee-responsible mitigation is the proposed option, the prospective permittee is responsible for submitting a mitigation plan. A conceptual or detailed mitigation plan may be used by the district engineer to make the decision on the NWP verification request, but a final mitigation plan that addresses the applicable requirements of 33 CFR 332.4(c)(2) – (14) must be approved by the district engineer before the permittee begins work in waters of the United States, unless the district engineer determines that prior approval of the final mitigation plan is not practicable or not necessary to ensure timely completion of the required compensatory mitigation (see 33 CFR 332.3(k)(3)).

(4) If mitigation bank or in-lieu fee program credits are the proposed option, the mitigation plan only needs to address the baseline conditions at the impact site and the number of credits to be provided.

(5) Compensatory mitigation requirements (e.g., resource type and amount to be provided as compensatory mitigation, site protection, ecological performance standards, monitoring

requirements) may be addressed through conditions added to the NWP authorization, instead of components of a compensatory mitigation plan.

(d) For losses of streams or other open waters that require pre-construction notification, the district engineer may require compensatory mitigation, such as stream rehabilitation, enhancement, or preservation, to ensure that the activity results in minimal adverse effects on the aquatic environment.

(e) Compensatory mitigation will not be used to increase the acreage losses allowed by the acreage limits of the NWPs. For example, if an NWP has an acreage limit of 1/2-acre, it cannot be used to authorize any project resulting in the loss of greater than 1/2-acre of waters of the United States, even if compensatory mitigation is provided that replaces or restores some of the lost waters. However, compensatory mitigation can and should be used, as necessary, to ensure that a project already meeting the established acreage limits also satisfies the minimal impact requirement associated with the NWPs.

(f) Compensatory mitigation plans for projects in or near streams or other open waters will normally include a requirement for the restoration or establishment, maintenance, and legal protection (e.g., conservation easements) of riparian areas next to open waters. In some cases, riparian areas may be the only compensatory mitigation required. Riparian areas should consist of native species. The width of the required riparian area will address documented water quality or aquatic habitat loss concerns. Normally, the riparian area will be 25 to 50 feet wide on each side of the stream, but the district engineer may require slightly wider riparian areas to address documented water quality or habitat loss concerns. If it is not possible to establish a riparian area on both sides of a stream, or if the waterbody is a lake or coastal waters, then restoring or establishing a riparian area along a single bank or shoreline may be sufficient. Where both wetlands and open waters exist on the project site, the district engineer will determine the appropriate compensatory mitigation (e.g., riparian areas and/or wetlands compensation) based on what is best for the aquatic environment on a watershed basis. In cases where riparian areas are determined to be the most appropriate form of compensatory mitigation, the district engineer may waive or reduce the requirement to provide wetland compensatory mitigation for wetland losses.

(g) Permittees may propose the use of mitigation banks, in-lieu fee programs, or separate permittee-responsible mitigation. For activities resulting in the loss of marine or estuarine resources, permittee-responsible compensatory mitigation may be environmentally preferable if there are no mitigation banks or in-lieu fee programs in the area that have marine or estuarine credits available for sale or transfer to the permittee. For permittee-responsible mitigation, the special conditions of the NWP verification must clearly indicate the party or parties responsible for the implementation and performance of the compensatory mitigation project, and, if required, its long-term management.

(h) Where certain functions and services of waters of the United States are permanently adversely affected, such as the conversion of a forested or scrub-shrub wetland to a herbaceous wetland in a permanently maintained utility line right-of-way, mitigation may be required to reduce the adverse effects of the project to the minimal level.

24. Safety of Impoundment Structures. To ensure that all impoundment structures are safely designed, the district engineer may require non-Federal applicants to demonstrate that the structures comply with established state dam safety criteria or have been designed by qualified persons. The district engineer may also require documentation that the design has been

independently reviewed by similarly qualified persons, and appropriate modifications made to ensure safety.

25. Water Quality. Where States and authorized Tribes, or EPA where applicable, have not previously certified compliance of an NWP with CWA Section 401, individual 401 Water Quality Certification must be obtained or waived (see 33 CFR 330.4(c)). The district engineer or State or Tribe may require additional water quality management measures to ensure that the authorized activity does not result in more than minimal degradation of water quality.

26. Coastal Zone Management. In coastal states where an NWP has not previously received a state coastal zone management consistency concurrence, an individual state coastal zone management consistency concurrence must be obtained, or a presumption of concurrence must occur (see 33 CFR 330.4(d)). The district engineer or a State may require additional measures to ensure that the authorized activity is consistent with state coastal zone management requirements.

27. Regional and Case-By-Case Conditions. The activity must comply with any regional conditions that may have been added by the Division Engineer (see 33 CFR 330.4(e)) and with any case specific conditions added by the Corps or by the state, Indian Tribe, or U.S. EPA in its section 401 Water Quality Certification, or by the state in its Coastal Zone Management Act consistency determination.

28. Use of Multiple Nationwide Permits. The use of more than one NWP for a single and complete project is prohibited, except when the acreage loss of waters of the United States authorized by the NWPs does not exceed the acreage limit of the NWP with the highest specified acreage limit. For example, if a road crossing over tidal waters is constructed under NWP 14, with associated bank stabilization authorized by NWP 13, the maximum acreage loss of waters of the United States for the total project cannot exceed 1/3-acre.

29. Transfer of Nationwide Permit Verifications. If the permittee sells the property associated with a nationwide permit verification, the permittee may transfer the nationwide permit verification to the new owner by submitting a letter to the appropriate Corps district office to validate the transfer. A copy of the nationwide permit verification must be attached to the letter, and the letter must contain the following statement and signature:

"When the structures or work authorized by this nationwide permit are still in existence at the time the property is transferred, the terms and conditions of this nationwide permit, including any special conditions, will continue to be binding on the new owner(s) of the property. To validate the transfer of this nationwide permit and the associated liabilities associated with compliance with its terms and conditions, have the transferee sign and date below."

_____

(Transferee)

_____

(Date)

30. Compliance Certification. Each permittee who receives an NWP verification letter from the Corps must provide a signed certification documenting completion of the authorized activity and any required compensatory mitigation. The success of any required permittee-responsible mitigation, including the achievement of ecological performance standards, will be addressed separately by the district engineer. The Corps will provide the permittee the certification document with the NWP verification letter. The certification document will include:

(a) A statement that the authorized work was done in accordance with the NWP authorization, including any general, regional, or activity-specific conditions;

(b) A statement that the implementation of any required compensatory mitigation was completed in accordance with the permit conditions. If credits from a mitigation bank or in-lieu fee program are used to satisfy the compensatory mitigation requirements, the certification must include the documentation required by 33 CFR 332.3(l)(3) to confirm that the permittee secured the appropriate number and resource type of credits; and

(c) The signature of the permittee certifying the completion of the work and mitigation.

31. Pre-Construction Notification. (a) Timing. Where required by the terms of the NWP, the prospective permittee must notify the district engineer by submitting a pre-construction notification (PCN) as early as possible. The district engineer must determine if the PCN is complete within 30 calendar days of the date of receipt and, if the PCN is determined to be incomplete, notify the prospective permittee within that 30 day period to request the additional information necessary to make the PCN complete. The request must specify the information needed to make the PCN complete. As a general rule, district engineers will request additional information necessary to make the PCN complete only once. However, if the prospective permittee does not provide all of the requested information, then the district engineer will notify the prospective permittee that the PCN is still incomplete and the PCN review process will not commence until all of the requested information has been received by the district engineer. The prospective permittee shall not begin the activity until either:

(1) He or she is notified in writing by the district engineer that the activity may proceed under the NWP with any special conditions imposed by the district or division engineer; or

(2) 45 calendar days have passed from the district engineer's receipt of the complete PCN and the prospective permittee has not received written notice from the district or division engineer. However, if the permittee was required to notify the Corps pursuant to general condition 18 that listed species or critical habitat might be affected or in the vicinity of the project, or to notify the Corps pursuant to general condition 20 that the activity may have the potential to cause effects to historic properties, the permittee cannot begin the activity until receiving written notification from the Corps that there is "no effect" on listed species or "no potential to cause effects" on historic properties, or that any consultation required under Section 7 of the Endangered Species Act (see 33 CFR 330.4(f)) and/or Section 106 of the National Historic Preservation (see 33 CFR 330.4(g)) has been completed. Also, work cannot begin under NWPs 21, 49, or 50 until the permittee has received written approval from the Corps. If the proposed activity requires a written waiver to exceed specified limits of an NWP, the permittee may not begin the activity until the district engineer issues the waiver. If the district or division engineer notifies the permittee in writing that an individual permit is required within 45 calendar days of receipt of a complete PCN, the permittee cannot begin the activity until an individual

permit has been obtained. Subsequently, the permittee's right to proceed under the NWP may be modified, suspended, or revoked only in accordance with the procedure set forth in 33 CFR 330.5(d)(2).

(b) Contents of Pre-Construction Notification: The PCN must be in writing and include the following information:

(1) Name, address and telephone numbers of the prospective permittee;

(2) Location of the proposed project;

(3) A description of the proposed project; the project's purpose; direct and indirect adverse environmental effects the project would cause, including the anticipated amount of loss of water of the United States expected to result from the NWP activity, in acres, linear feet, or other appropriate unit of measure; any other NWP(s), regional general permit(s), or individual permit(s) used or intended to be used to authorize any part of the proposed project or any related activity. The description should be sufficiently detailed to allow the district engineer to determine that the adverse effects of the project will be minimal and to determine the need for compensatory mitigation. Sketches should be provided when necessary to show that the activity complies with the terms of the NWP. (Sketches usually clarify the project and when provided results in a quicker decision. Sketches should contain sufficient detail to provide an illustrative description of the proposed activity (e.g., a conceptual plan), but do not need to be detailed engineering plans);

(4) The PCN must include a delineation of wetlands, other special aquatic sites, and other waters, such as lakes and ponds, and perennial, intermittent, and ephemeral streams, on the project site. Wetland delineations must be prepared in accordance with the current method required by the Corps. The permittee may ask the Corps to delineate the special aquatic sites and other waters on the project site, but there may be a delay if the Corps does the delineation, especially if the project site is large or contains many waters of the United States. Furthermore, the 45 day period will not start until the delineation has been submitted to or completed by the Corps, as appropriate;

(5) If the proposed activity will result in the loss of greater than 1/10-acre of wetlands and a PCN is required, the prospective permittee must submit a statement describing how the mitigation requirement will be satisfied, or explaining why the adverse effects are minimal and why compensatory mitigation should not be required. As an alternative, the prospective permittee may submit a conceptual or detailed mitigation plan.

(6) If any listed species or designated critical habitat might be affected or is in the vicinity of the project, or if the project is located in designated critical habitat, for non-Federal applicants the PCN must include the name(s) of those endangered or threatened species that might be affected by the proposed work or utilize the designated critical habitat that may be affected by the proposed work. Federal applicants must provide documentation demonstrating compliance with the Endangered Species Act; and

(7) For an activity that may affect a historic property listed on, determined to be eligible for listing on, or potentially eligible for listing on, the National Register of Historic Places, for non-Federal applicants the PCN must state which historic property may be affected by the proposed work or include a vicinity map indicating the location of the historic property. Federal applicants must provide documentation demonstrating compliance with Section 106 of the National Historic Preservation Act.

(c) Form of Pre-Construction Notification: The standard individual permit application form (Form ENG 4345) may be used, but the completed application form must clearly indicate

that it is a PCN and must include all of the information required in paragraphs (b)(1) through (7) of this general condition. A letter containing the required information may also be used.

(d) Agency Coordination: (1) The district engineer will consider any comments from Federal and state agencies concerning the proposed activity's compliance with the terms and conditions of the NWPs and the need for mitigation to reduce the project's adverse environmental effects to a minimal level.

(2) For all NWP activities that require pre-construction notification and result in the loss of greater than 1/2-acre of waters of the United States, for NWP 21, 29, 39, 40, 42, 43, 44, 50, 51, and 52 activities that require pre-construction notification and will result in the loss of greater than 300 linear feet of intermittent and ephemeral stream bed, and for all NWP 48 activities that require pre-construction notification, the district engineer will immediately provide (e.g., via e-mail, facsimile transmission, overnight mail, or other expeditious manner) a copy of the complete PCN to the appropriate Federal or state offices (U.S. FWS, state natural resource or water quality agency, EPA, State Historic Preservation Officer (SHPO) or Tribal Historic Preservation Office (THPO), and, if appropriate, the NMFS). With the exception of NWP 37, these agencies will have 10 calendar days from the date the material is transmitted to telephone or fax the district engineer notice that they intend to provide substantive, site-specific comments. The comments must explain why the agency believes the adverse effects will be more than minimal. If so contacted by an agency, the district engineer will wait an additional 15 calendar days before making a decision on the pre-construction notification. The district engineer will fully consider agency comments received within the specified time frame concerning the proposed activity's compliance with the terms and conditions of the NWPs, including the need for mitigation to ensure the net adverse environmental effects to the aquatic environment of the proposed activity are minimal. The district engineer will provide no response to the resource agency, except as provided below. The district engineer will indicate in the administrative record associated with each pre-construction notification that the resource agencies' concerns were considered. For NWP 37, the emergency watershed protection and rehabilitation activity may proceed immediately in cases where there is an unacceptable hazard to life or a significant loss of property or economic hardship will occur. The district engineer will consider any comments received to decide whether the NWP 37 authorization should be modified, suspended, or revoked in accordance with the procedures at 33 CFR 330.5.

(3) In cases of where the prospective permittee is not a Federal agency, the district engineer will provide a response to NMFS within 30 calendar days of receipt of any Essential Fish Habitat conservation recommendations, as required by Section 305(b)(4)(B) of the Magnuson-Stevens Fishery Conservation and Management Act.

(4) Applicants are encouraged to provide the Corps with either electronic files or multiple copies of pre-construction notifications to expedite agency coordination.

D. District Engineer's Decision

1. In reviewing the PCN for the proposed activity, the district engineer will determine whether the activity authorized by the NWP will result in more than minimal individual or cumulative adverse environmental effects or may be contrary to the public interest. For a linear project, this determination will include an evaluation of the individual crossings to determine whether they individually satisfy the terms and conditions of the NWP(s), as well as the cumulative effects caused by all of the crossings authorized by NWP. If an applicant requests a

waiver of the 300 linear foot limit on impacts to intermittent or ephemeral streams or of an otherwise applicable limit, as provided for in NWPs 13, 21, 29, 36, 39, 40, 42, 43, 44, 50, 51 or 52, the district engineer will only grant the waiver upon a written determination that the NWP activity will result in minimal adverse effects. When making minimal effects determinations the district engineer will consider the direct and indirect effects caused by the NWP activity. The district engineer will also consider site specific factors, such as the environmental setting in the vicinity of the NWP activity, the type of resource that will be affected by the NWP activity, the functions provided by the aquatic resources that will be affected by the NWP activity, the degree or magnitude to which the aquatic resources perform those functions, the extent that aquatic resource functions will be lost as a result of the NWP activity (e.g., partial or complete loss), the duration of the adverse effects (temporary or permanent), the importance of the aquatic resource functions to the region (e.g., watershed or ecoregion), and mitigation required by the district engineer. If an appropriate functional assessment method is available and practicable to use, that assessment method may be used by the district engineer to assist in the minimal adverse effects determination. The district engineer may add case-specific special conditions to the NWP authorization to address site-specific environmental concerns.

2. If the proposed activity requires a PCN and will result in a loss of greater than 1/10-acre of wetlands, the prospective permittee should submit a mitigation proposal with the PCN. Applicants may also propose compensatory mitigation for projects with smaller impacts. The district engineer will consider any proposed compensatory mitigation the applicant has included in the proposal in determining whether the net adverse environmental effects to the aquatic environment of the proposed activity are minimal. The compensatory mitigation proposal may be either conceptual or detailed. If the district engineer determines that the activity complies with the terms and conditions of the NWP and that the adverse effects on the aquatic environment are minimal, after considering mitigation, the district engineer will notify the permittee and include any activity-specific conditions in the NWP verification the district engineer deems necessary. Conditions for compensatory mitigation requirements must comply with the appropriate provisions at 33 CFR 332.3(k). The district engineer must approve the final mitigation plan before the permittee commences work in waters of the United States, unless the district engineer determines that prior approval of the final mitigation plan is not practicable or not necessary to ensure timely completion of the required compensatory mitigation. If the prospective permittee elects to submit a compensatory mitigation plan with the PCN, the district engineer will expeditiously review the proposed compensatory mitigation plan. The district engineer must review the proposed compensatory mitigation plan within 45 calendar days of receiving a complete PCN and determine whether the proposed mitigation would ensure no more than minimal adverse effects on the aquatic environment. If the net adverse effects of the project on the aquatic environment (after consideration of the compensatory mitigation proposal) are determined by the district engineer to be minimal, the district engineer will provide a timely written response to the applicant. The response will state that the project can proceed under the terms and conditions of the NWP, including any activity-specific conditions added to the NWP authorization by the district engineer.

3. If the district engineer determines that the adverse effects of the proposed work are more than minimal, then the district engineer will notify the applicant either: (a) That the project does not qualify for authorization under the NWP and instruct the applicant on the procedures to

seek authorization under an individual permit; (b) that the project is authorized under the NWP subject to the applicant's submission of a mitigation plan that would reduce the adverse effects on the aquatic environment to the minimal level; or (c) that the project is authorized under the NWP with specific modifications or conditions. Where the district engineer determines that mitigation is required to ensure no more than minimal adverse effects occur to the aquatic environment, the activity will be authorized within the 45-day PCN period, with activity-specific conditions that state the mitigation requirements. The authorization will include the necessary conceptual or detailed mitigation or a requirement that the applicant submit a mitigation plan that would reduce the adverse effects on the aquatic environment to the minimal level. When mitigation is required, no work in waters of the United States may occur until the district engineer has approved a specific mitigation plan or has determined that prior approval of a final mitigation plan is not practicable or not necessary to ensure timely completion of the required compensatory mitigation.

E. Further Information

1. District Engineers have authority to determine if an activity complies with the terms and conditions of an NWP.

2. NWPs do not obviate the need to obtain other federal, state, or local permits, approvals, or authorizations required by law.

3. NWPs do not grant any property rights or exclusive privileges.

4. NWPs do not authorize any injury to the property or rights of others.

5. NWPs do not authorize interference with any existing or proposed Federal project.

F. Definitions

Best management practices (BMPs): Policies, practices, procedures, or structures implemented to mitigate the adverse environmental effects on surface water quality resulting from development. BMPs are categorized as structural or non-structural.

Compensatory mitigation: The restoration (re-establishment or rehabilitation), establishment (creation), enhancement, and/or in certain circumstances preservation of aquatic resources for the purposes of offsetting unavoidable adverse impacts which remain after all appropriate and practicable avoidance and minimization has been achieved.

Currently serviceable: Useable as is or with some maintenance, but not so degraded as to essentially require reconstruction.

Direct effects: Effects that are caused by the activity and occur at the same time and place.

Discharge: The term "discharge" means any discharge of dredged or fill material.

Enhancement: The manipulation of the physical, chemical, or biological characteristics of an aquatic resource to heighten, intensify, or improve a specific aquatic resource function(s). Enhancement results in the gain of selected aquatic resource function(s), but may also lead to a decline in other aquatic resource function(s). Enhancement does not result in a gain in aquatic resource area.

Ephemeral stream: An ephemeral stream has flowing water only during, and for a short duration after, precipitation events in a typical year. Ephemeral stream beds are located above the

water table year-round. Groundwater is not a source of water for the stream. Runoff from rainfall is the primary source of water for stream flow.

Establishment (creation): The manipulation of the physical, chemical, or biological characteristics present to develop an aquatic resource that did not previously exist at an upland site. Establishment results in a gain in aquatic resource area.

High Tide Line: The line of intersection of the land with the water's surface at the maximum height reached by a rising tide. The high tide line may be determined, in the absence of actual data, by a line of oil or scum along shore objects, a more or less continuous deposit of fine shell or debris on the foreshore or berm, other physical markings or characteristics, vegetation lines, tidal gages, or other suitable means that delineate the general height reached by a rising tide. The line encompasses spring high tides and other high tides that occur with periodic frequency but does not include storm surges in which there is a departure from the normal or predicted reach of the tide due to the piling up of water against a coast by strong winds such as those accompanying a hurricane or other intense storm.

Historic Property: Any prehistoric or historic district, site (including archaeological site), building, structure, or other object included in, or eligible for inclusion in, the National Register of Historic Places maintained by the Secretary of the Interior. This term includes artifacts, records, and remains that are related to and located within such properties. The term includes properties of traditional religious and cultural importance to an Indian tribe or Native Hawaiian organization and that meet the National Register criteria (36 CFR part 60).

Independent utility: A test to determine what constitutes a single and complete non-linear project in the Corps regulatory program. A project is considered to have independent utility if it would be constructed absent the construction of other projects in the project area. Portions of a multi-phase project that depend upon other phases of the project do not have independent utility. Phases of a project that would be constructed even if the other phases were not built can be considered as separate single and complete projects with independent utility.

Indirect effects: Effects that are caused by the activity and are later in time or farther removed in distance, but are still reasonably foreseeable.

Intermittent stream: An intermittent stream has flowing water during certain times of the year, when groundwater provides water for stream flow. During dry periods, intermittent streams may not have flowing water. Runoff from rainfall is a supplemental source of water for stream flow.

Loss of waters of the United States: Waters of the United States that are permanently adversely affected by filling, flooding, excavation, or drainage because of the regulated activity. Permanent adverse effects include permanent discharges of dredged or fill material that change an aquatic area to dry land, increase the bottom elevation of a waterbody, or change the use of a waterbody. The acreage of loss of waters of the United States is a threshold measurement of the impact to jurisdictional waters for determining whether a project may qualify for an NWP; it is not a net threshold that is calculated after considering compensatory mitigation that may be used to offset losses of aquatic functions and services. The loss of stream bed includes the linear feet of stream bed that is filled or excavated. Waters of the United States temporarily filled, flooded, excavated, or drained, but restored to pre-construction contours and elevations after construction, are not included in the measurement of loss of waters of the United States. Impacts resulting from activities eligible for exemptions under Section 404(f) of the Clean Water Act are not considered when calculating the loss of waters of the United States.

Non-tidal wetland: A non-tidal wetland is a wetland that is not subject to the ebb and flow of tidal waters. The definition of a wetland can be found at 33 CFR 328.3(b). Non-tidal wetlands contiguous to tidal waters are located landward of the high tide line (i.e., spring high tide line).

Open water: For purposes of the NWPs, an open water is any area that in a year with normal patterns of precipitation has water flowing or standing above ground to the extent that an ordinary high water mark can be determined. Aquatic vegetation within the area of standing or flowing water is either non-emergent, sparse, or absent. Vegetated shallows are considered to be open waters. Examples of "open waters" include rivers, streams, lakes, and ponds.

Ordinary High Water Mark: An ordinary high water mark is a line on the shore established by the fluctuations of water and indicated by physical characteristics, or by other appropriate means that consider the characteristics of the surrounding areas (see 33 CFR 328.3(e)).

Perennial stream: A perennial stream has flowing water year-round during a typical year. The water table is located above the stream bed for most of the year. Groundwater is the primary source of water for stream flow. Runoff from rainfall is a supplemental source of water for stream flow.

Practicable: Available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes.

Pre-construction notification: A request submitted by the project proponent to the Corps for confirmation that a particular activity is authorized by nationwide permit. The request may be a permit application, letter, or similar document that includes information about the proposed work and its anticipated environmental effects. Pre-construction notification may be required by the terms and conditions of a nationwide permit, or by regional conditions. A pre-construction notification may be voluntarily submitted in cases where pre-construction notification is not required and the project proponent wants confirmation that the activity is authorized by nationwide permit.

Preservation: The removal of a threat to, or preventing the decline of, aquatic resources by an action in or near those aquatic resources. This term includes activities commonly associated with the protection and maintenance of aquatic resources through the implementation of appropriate legal and physical mechanisms. Preservation does not result in a gain of aquatic resource area or functions.

Re-establishment: The manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural/historic functions to a former aquatic resource. Re-establishment results in rebuilding a former aquatic resource and results in a gain in aquatic resource area and functions.

Rehabilitation: The manipulation of the physical, chemical, or biological characteristics of a site with the goal of repairing natural/historic functions to a degraded aquatic resource. Rehabilitation results in a gain in aquatic resource function, but does not result in a gain in aquatic resource area.

Restoration: The manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural/historic functions to a former or degraded aquatic resource. For the purpose of tracking net gains in aquatic resource area, restoration is divided into two categories: re-establishment and rehabilitation.

Riffle and pool complex: Riffle and pool complexes are special aquatic sites under the 404(b)(1) Guidelines. Riffle and pool complexes sometimes characterize steep gradient sections

of streams. Such stream sections are recognizable by their hydraulic characteristics. The rapid movement of water over a course substrate in riffles results in a rough flow, a turbulent surface, and high dissolved oxygen levels in the water. Pools are deeper areas associated with riffles. A slower stream velocity, a streaming flow, a smooth surface, and a finer substrate characterize pools.

Riparian areas: Riparian areas are lands adjacent to streams, lakes, and estuarine-marine shorelines. Riparian areas are transitional between terrestrial and aquatic ecosystems, through which surface and subsurface hydrology connects riverine, lacustrine, estuarine, and marine waters with their adjacent wetlands, non-wetland waters, or uplands. Riparian areas provide a variety of ecological functions and services and help improve or maintain local water quality. (See general condition 23.)

Shellfish seeding: The placement of shellfish seed and/or suitable substrate to increase shellfish production. Shellfish seed consists of immature individual shellfish or individual shellfish attached to shells or shell fragments (i.e., spat on shell). Suitable substrate may consist of shellfish shells, shell fragments, or other appropriate materials placed into waters for shellfish habitat.

Single and complete linear project: A linear project is a project constructed for the purpose of getting people, goods, or services from a point of origin to a terminal point, which often involves multiple crossings of one or more waterbodies at separate and distant locations. The term "single and complete project" is defined as that portion of the total linear project proposed or accomplished by one owner/developer or partnership or other association of owners/developers that includes all crossings of a single water of the United States (i.e., a single waterbody) at a specific location. For linear projects crossing a single or multiple waterbodies several times at separate and distant locations, each crossing is considered a single and complete project for purposes of NWP authorization. However, individual channels in a braided stream or river, or individual arms of a large, irregularly shaped wetland or lake, etc., are not separate waterbodies, and crossings of such features cannot be considered separately.

Single and complete non-linear project: For non-linear projects, the term "single and complete project" is defined at 33 CFR 330.2(i) as the total project proposed or accomplished by one owner/developer or partnership or other association of owners/developers. A single and complete non-linear project must have independent utility (see definition of "independent utility"). Single and complete non-linear projects may not be "piecemealed" to avoid the limits in an NWP authorization.

Stormwater management: Stormwater management is the mechanism for controlling stormwater runoff for the purposes of reducing downstream erosion, water quality degradation, and flooding and mitigating the adverse effects of changes in land use on the aquatic environment.

Stormwater management facilities: Stormwater management facilities are those facilities, including but not limited to, stormwater retention and detention ponds and best management practices, which retain water for a period of time to control runoff and/or improve the quality (i.e., by reducing the concentration of nutrients, sediments, hazardous substances and other pollutants) of stormwater runoff.

Stream bed: The substrate of the stream channel between the ordinary high water marks. The substrate may be bedrock or inorganic particles that range in size from clay to boulders. Wetlands contiguous to the stream bed, but outside of the ordinary high water marks, are not considered part of the stream bed.

Stream channelization: The manipulation of a stream's course, condition, capacity, or location that causes more than minimal interruption of normal stream processes. A channelized stream remains a water of the United States.

Structure: An object that is arranged in a definite pattern of organization. Examples of structures include, without limitation, any pier, boat dock, boat ramp, wharf, dolphin, weir, boom, breakwater, bulkhead, revetment, riprap, jetty, artificial island, artificial reef, permanent mooring structure, power transmission line, permanently moored floating vessel, piling, aid to navigation, or any other manmade obstacle or obstruction.

Tidal wetland: A tidal wetland is a wetland (i.e., water of the United States) that is inundated by tidal waters. The definitions of a wetland and tidal waters can be found at 33 CFR 328.3(b) and 33 CFR 328.3(f), respectively. Tidal waters rise and fall in a predictable and measurable rhythm or cycle due to the gravitational pulls of the moon and sun. Tidal waters end where the rise and fall of the water surface can no longer be practically measured in a predictable rhythm due to masking by other waters, wind, or other effects. Tidal wetlands are located channelward of the high tide line, which is defined at 33 CFR 328.3(d).

Vegetated shallows: Vegetated shallows are special aquatic sites under the 404(b)(1) Guidelines. They are areas that are permanently inundated and under normal circumstances have rooted aquatic vegetation, such as seagrasses in marine and estuarine systems and a variety of vascular rooted plants in freshwater systems.

Waterbody: For purposes of the NWPs, a waterbody is a jurisdictional water of the United States. If a jurisdictional wetland is adjacent – meaning bordering, contiguous, or neighboring – to a waterbody determined to be a water of the United States under 33 CFR 328.3(a)(1)-(6), that waterbody and its adjacent wetlands are considered together as a single aquatic unit (see 33 CFR 328.4(c)(2)). Examples of "waterbodies" include streams, rivers, lakes, ponds, and wetlands.

ADDITIONAL INFORMATION

This nationwide permit is effective March 19, 2012, and expires on March 18, 2017.

Information about the U.S. Army Corps of Engineers regulatory program, including nationwide permits, may also be accessed at http://www.swf.usace.army.mil/regulatory or http://www.usace.army.mil/Missions/CivilWorks/RegulatoryProgramandPermits.aspx

NATIONWIDE PERMIT (NWP) REGIONAL CONDITIONS FOR THE STATE OF TEXAS

The following regional conditions apply within the entire State of Texas:

1. Compensatory mitigation is required at a minimum one-for-one ratio for all special aquatic site losses that exceed 1/10 acre and require pre-construction notification (PCN), and for all losses to streams that exceed 300 linear feet and require PCN, unless the appropriate District Engineer determines in writing that some other form of mitigation would be more environmentally appropriate and provides a project-specific waiver of this requirement.

2. For all discharges proposed for authorization under nationwide permits (NWP) 3, 6, 7, 12, 14, 18, 19, 25, 27, 29, 39, 40, 41, 42, 43, 44, 51, and 52, into the following habitat types or specific areas, the applicant shall notify the appropriate District Engineer in accordance with the NWP General Condition 31, Pre-Construction Notification (PCN). The Corps of Engineers (Corps), except for the Tulsa District, will coordinate with the resource agencies as specified in NWP General Condition 31(d) (PCN). The habitat types or areas are:

a. Pitcher Plant Bogs: Wetlands typically characterized by an organic surface soil layer and include vegetation such as pitcher plants (Sarracenia sp.), sundews (Drosera sp.), and sphagnum moss (Sphagnum sp.).

b. Bald Cypress-Tupelo Swamps: Wetlands comprised predominantly of bald cypress trees (Taxodium distichum), and water tupelo trees (Nyssa aquatica), that are occasionally or regularly flooded by fresh water. Common associates include red maple (Acer rubrum), swamp privet (Forestiera acuminata), green ash (Fraxinus pennsylvanica) and water elm (Planera aquatica). Associated herbaceous species include lizard's tail (Saururus cernuus), water mermaid weed (Proserpinaca spp.), buttonbush (Cephalanthus occidentalis) and smartweed (Polygonum spp.). (Eyre, F. H. Forest Cover Types of the United States and Canada. 1980. Society of American Foresters, 5400 Grosvenor Lane, Bethesda, Maryland 20814-2198. Library of Congress Catalog Card No. 80-54185)

3. For all activities proposed for authorization under NWP 12 that involve a discharge of fill material associated with mechanized land clearing in a forested wetland, the applicant shall notify the appropriate District Engineer in accordance with the NWP General Condition 31 (Pre-Construction Notification) prior to commencing the activity.

4. For all activities proposed for authorization under NWP 16, the applicant shall notify the appropriate District Engineer in accordance with the NWP General Condition 31 (Pre-Construction Notification), and work cannot begin under NWP 16 until the applicant has received written approval from the Corps.

The following regional conditions apply only within the Fort Worth District in the State of Texas:

5. For all discharges proposed for authorization under all NWPs, into the area of Caddo Lake within Texas that is designated as a “Wetland of International Importance” under the Ramsar Convention, the applicant shall notify the Fort Worth District Engineer in accordance with the NWP General Condition 31. The Corps will coordinate with the resource agencies as specified in NWP General Condition 31(d) (Pre-Construction Notification).

6. For all discharges proposed for authorization under NWP 43 that occur in forested wetlands, the applicant shall notify the Fort Worth District Engineer in accordance with the General Condition 31 (Pre-Construction Notification).

7. For all discharges proposed for authorization under any nationwide permit in Dallas, Denton, and Tarrant Counties that are within the study area of the "Final Regional Environmental Impact Statement (EIS), Trinity River and Tributaries" (May 1986), the applicant shall meet the criteria and follow the guidelines specified in Section III of the Record of Decision for the Regional EIS, including the hydraulic impact requirements. A copy of these guidelines is available upon request from the Fort Worth District and at the District website www.swf.usace.army.mil (select "Permits").

8. Federal Projects. The applicant shall notify the Forth Worth District Engineer in accordance with the NWP General Condition 31, Pre-Construction Notification (PCN) for any regulated activity where the applicant is proposing work that would result in the modification or alteration of any completed Corps of Engineer projects that are either locally or federally maintained and for work that would occur within the conservation pool or flowage easement of any Corps of Engineers lake project. PCN's cannot be deemed complete until such time as the Corps has made a determination relative to 33 USC Section 408, 33 CFR Part 208, Section 208.10, 33 CFR Part 320, Section 320.4.

9. Invasive and Exotic Species. Best management practices are required where practicable to reduce the risk of transferring invasive plant and animal species to or from project sites. Information concerning state specific lists and threats can be found at: http://www.invasivespeciesinfo.gov/unitedstates/tx.shtml. Best management practices can be found at: http://www.invasivespeciesinfo.gov/toolkit/prevention.shtml. Known zebra mussel waters within can be found at: http://nas.er.usgs.gov/queries/zmbyst.asp.

10. For all discharges proposed for authorization under NWPs 51 and 52, the Corps will provide the PCN to the US Fish and Wildlife Service as specified in NWP General Condition 31(d)(2) for its review and comments.

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

April 5, 2012

Ms. Kristi N. McMillan
Galveston District CESWG-PE-RE
U.S. Army Corps of Engineers
P.O. Box 1229
Galveston, Texas 77553-1229

Re: USACE Nationwide Permits

Dear Ms. McMillan:

This letter is in response to your January 23, 2012, letter requesting Clean Water Act Section 401 certification of the United States Army Corps of Engineers (Corps) Nationwide Permits (NWPs). The Final Notice of Reissuance of Nationwide Permits was published in the Federal Register (Vol. 77, No. 34, pages 10184-10290) on February 21, 2012. Proposed regional conditions for NWPs in Texas were proposed in public notices on February 24, 2011 and November 14, 2011.

The Texas Commission on Environmental Quality (TCEQ) has reviewed the Final Notice of Reissuance of Nationwide Permits and the proposed regional conditions. On behalf of the Executive Director and based on our evaluation of the information contained in these documents, the TCEQ certifies that the activities authorized by NWPs 1, 2, 4, 5, 8, 9, 10, 11, 20, 23, 24, 28, 34, 35, and 48 should not result in a violation of established Texas Surface Water Quality Standards as required by Section 401 of the Federal Clean Water Act and pursuant to Title 30, Texas Administrative Code, Chapter 279.

The TCEQ conditionally certifies that the activities authorized by NWPs 3, 6, 7, 12, 13, 14, 15, 17, 18, 19, 21, 22, 25, 27, 29, 30, 31, 32, 33, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 49, 50, 51 and 52 should not result in a violation of established Texas Surface Water Quality Standards as required by Section 401 of the Federal Clean Water Act and pursuant to Title 30, Texas Administrative Code, Chapter 279. Conditions for each NWP are defined in Enclosure 1 and more detail on specific conditions are discussed below.

The TCEQ understands that a prohibition against the use of NWPs in coastal dune swales will be included in the 2012 Texas Regional Conditions (Regional Conditions) for all NWPs, except for NWP 3. Inclusion of a prohibition of using NWPs in coastal dune swales, except for NWP 3, is a condition of this 401 TCEQ certification.

The TCEQ wants to clarify the application of NWP 16 in Texas. NWP 16 should be limited to the return water from upland contained dredged material disposal areas. It is important to emphasize the intent for dredged material disposal. The TCEQ understands dredged material to be associated with navigational dredging activities, not commercial mining activities. To avoid confusion the TCEQ requests that a regional condition be added that prohibits the use of NWP 16 for activities that would be regulated under Standard Industrial Classification (SIC) codes 1442 and 1446 (industrial and construction sand and gravel mining). This condition is also included as part of the 401 certification of NWP 16.

The final NWP 16 states that the quality of the return water is controlled by the state through the 401 certification procedures. Consistent with previous NWPs certification decisions the TCEQ is conditionally certifying NWP 16 for the return water from confined upland disposal not to exceed a 300 mg/L Total Suspended Solids (TSS) concentration and request the Corps to include this condition in the Regional Conditions. The TCEQ recognizes the usefulness of having an instantaneous method to determine compliance with the 300 mg/L TSS limit. However, existing literature and analysis of paired samples of turbidity and TSS from the Texas Surface Water Quality Data indicate this relationship must be a site specific characterization of the actual sediments to be dredged. To address this approach we have continued language in the NWP 16 conditional certification that allows flexibility to use an instantaneous method in implementing the TSS limit when a site specific correlation curve for turbidity (nephelometric turbidity units (NTU)) versus TSS has been approved by TCEQ. The TCEQ remains interested in working with the Corps in the development of these curves. We encourage the Corps to accept the conditional certification of NWP 16 as a Regional Condition and that we work together to find the best methods to implement this limit.

In evaluating this condition for the Regional Conditions for NWPs, the TCEQ encourages the Corps to consider that TSS limits are promulgated as effluent limits under Title 40 of the Code of Federal Regulations. The TCEQ requirement to control return water from confined upland disposal not to exceed a 300 mg/L TSS has also been included in individual 404 permits. It is also important to note that the TCEQ effectively imposes TSS effluent limits in thousands of wastewater discharge permits issued in Texas under Section 402 of the federal Clean Water Act.

The TCEQ is conditionally certifying NWP General Condition #12 *Soil Erosion and Sediment Controls*, and General Condition #25 *Water Quality*. The conditions address three broad categories of water quality management with specific recommendations for Best Management Practices (BMPs) for each category. These BMPs are intended to enhance the water quality protection of these General Conditions. A list of TCEQ-recommended BMPs is included as Enclosure 2.

Enclosure 3 is provided as a quick reference table for all NWPs. A detailed description of the BMPs is provided in Enclosure 4. Runoff from bridge decks has been exempted from the requirement for post-construction total suspended solids (TSS) controls under General Condition 25. As stated in our April 11, 2011 and November 30, 2011 letters to the Corps, the TCEQ would like to include these BMPs for the protection of waters in the state specific to each NWP as part of the regional conditions for Texas.

The TCEQ is conditionally certifying NWPs 13, 29, 39, 40, 41, 42, 43, 44, 50, 51, and 52 to require the Corps to copy TCEQ on all written approvals of waivers for impacts to ephemeral, intermittent or perennial streams. The TCEQ is conditionally certifying NWP 36 to require the Corps to copy TCEQ on all written waivers for discharges greater than the 50 cubic yard limit or boat ramps greater than 20 feet in width. The TCEQ is also conditionally certifying General Condition 23 *Mitigation* to require the Corps to copy TCEQ on any written notification of a mitigation waiver. The TCEQ is requesting this information to fulfill its responsibility to ensure water of the state is appropriately protected by understanding the impact of waivers being granted in Texas.

This certification decision is limited to those activities under the jurisdiction of the TCEQ. For activities related to the production and exploration of oil and gas, a Texas Railroad Commission certification is required as provided in the Texas Water Code §26.131.

The TCEQ has reviewed the Notice of Reissuance of Nationwide Permits for consistency with the Texas Coastal Management Program (CMP) goals and policies in accordance with the CMP regulations {Title 31, Texas Administrative Code (TAC), Chapter (§)505.30} and has determined that the action is consistent with the applicable CMP goals and policies.

This certification was reviewed for consistency with the CMP's development in critical areas policy {31 TAC §501.23} and dredging and dredged material disposal and placement policy {31 TAC §501.25}. This certification complies with the CMP goals {31 TAC §501.12(1, 2, 3, 5)} applicable to these policies.

The TCEQ reserves the right to modify this certification if additional information identifies specific areas where significant impacts, including cumulative or secondary impacts, are occurring, and the use of these NWPs would be inappropriate.

No review of property rights, location of property lines, nor the distinction between public and private ownership has been made, and this certification may not be used in any way with regard to questions of ownership.

If you require further assistance, please contact Mr. John Trevino, Water Quality Assessment Section, Water Quality Division (MC-150), at (512) 239-4600.

Sincerely,

Charles W. Maguire
Water Quality Division Director
Texas Commission on Environmental Quality

CWM/JT/gg

Attachments

ccs: Mr. Stephen Brooks, Branch Chief, U.S. Army Corp of Engineers, Regulatory Branch, CESWF-PER-R, P.O. Box 17300, Fort Worth, Texas 76102-0300
Ms. Kate Zultner, Secretary, Coastal Coordination Council, P.O. Box 12873, Austin, Texas 78711-2873
Mr. Allan E. Steinle, Branch Chief, U.S. Army Corps of Engineers, Albuquerque District, 4101 Jefferson Plaza NE, Room 313, Albuquerque, New Mexico 87109-3435
Regulatory Branch Chief, U.S. Army Corps of Engineers, Regulatory Branch CESWT-PE-R, 1645 South 101st East Avenue, Tulsa, Oklahoma, 74128
Regulatory Branch Chief, U.S. Army Corps of Engineers, El Paso Regulatory Office, CESPA-OD-R-EP, P.O. Box 6096, Fort Bliss, Texas 79906-6096

Attachment 1

Attachment 1
Conditions of Section 401 Certification for Nationwide Permits and General Conditions

General Condition 12 (Soil Erosion and Sediment Controls)

Erosion control and sediment control BMPs described in Attachment 2 are required with the use of this general condition. If the applicant does not choose one of the BMPs listed in Attachment 2, an individual 401 certification is required.

General Condition 25 (Water Quality)

Post-construction total suspended solids (TSS) BMPs described in Attachment 2 are required with the use of this general condition. If the applicant does not choose one of the BMP's listed in Attachment 2, an individual 401 certification is required. Bridge deck runoff is exempt from this requirement.

General Condition 23 (Mitigation)

The U.S. Army Corps of Engineers will copy the TCEQ on all mitigation waivers sent to applicants.

NWPs 13, 29, 39, 40, 41, 42, 43, 44, 50, 51, 52

The U.S. Army Corps of Engineers will copy the TCEQ on all written approvals of waivers for impacts to ephemeral, intermittent or perennial streams.

All NWPs except for NWP 3

These NWPs are not authorized for use in coastal dune swales in Texas.

NWP 3 (Maintenance)

Soil Erosion and Sediment Controls under General Condition 12 are required.

NWP 6 (Survey Activities)

Soil Erosion and Sediment Controls under General Condition 12 are required.

NWP 7 (Outfall Structures and Associated Intake Structures)

Soil Erosion and Sediment Controls under General Condition 12 are required.

NWP 12 (Utility Line Activities)

Soil Erosion and Sediment Controls under General Condition 12 are required. Post-construction TSS controls under General Condition 25 are required.

NWP 13 (Bank Stabilization)

Soil Erosion and Sediment Controls under General Condition 12 are required.

NWP 14 (Linear Transportation Projects)

Soil Erosion and Sediment Controls under General Condition 12 are required. Post-construction TSS controls under General Condition 25 are required.

NWP 15 (U.S. Coast Guard Approved Bridges)

Soil Erosion and Sediment Controls under General Condition 12 are required.

NWP 16 (Return Water From Upland Contained Disposal Areas)

Activities that would be regulated under Standard Industrial Classification (SIC) codes 1442 and 1446 (industrial and construction sand and gravel mining) are not eligible for this NWP. Effluent from an upland contained disposal area shall not exceed a TSS concentration of 300 mg/L unless a site-specific TSS limit, or a site specific correlation curve for turbidity (nephelometric turbidity units (NTU)) versus (TSS) has been approved by TCEQ.

NWP 17 (Hydropower Projects)

Soil Erosion and Sediment Controls under General Condition 12 are required. Post-construction TSS controls under General Condition 25 are required.

NWP 18 (Minor Discharges)

Soil Erosion and Sediment Controls under General Condition 12 are required. Post-construction TSS controls under General Condition 25 are required.

NWP 19 (Minor Dredging)

Soil Erosion and Sediment Controls under General Condition 12 are required.

NWP 21 (Surface Coal Mining Operations)

Soil Erosion and Sediment Controls under General Condition 12 are required. Post-construction TSS controls under General Condition 25 are required.

NWP 22 (Removal of Vessels)

Soil Erosion and Sediment Controls under General Condition 12 are required.

NWP 25 (Structural Discharges)

Soil Erosion and Sediment Controls under General Condition 12 are required.

NWP 27 (Aquatic Habitat Restoration, Establishment, and Enhancement Activities)

Soil Erosion and Sediment Controls under General Condition 12 are required.

NWP 29 (Residential Developments)

Soil Erosion and Sediment Controls under General Condition 12 are required. Post-construction TSS controls under General Condition 25 are required.

NWP 30 (Moist Soil Management for Wildlife)

Soil Erosion and Sediment Controls under General Condition 12 are required.

NWP 31 (Maintenance of Existing Flood Control Facilities)

Soil Erosion and Sediment Controls under General Condition 12 are required. Post-construction TSS controls under General Condition 25 are required.

NWP 32 (Completed Enforcement Actions)

Soil Erosion and Sediment Controls under General Condition 12 are required.

NWP 33 (Temporary Construction, Access and Dewatering)

Soil Erosion and Sediment Controls under General Condition 12 are required.

NWP 36 (Boat Ramps)

The U.S. Army Corps of Engineers will copy the TCEQ on all written waivers for discharges greater than the 50 cubic yard limit or boat ramps greater than 20 feet in width. Soil Erosion and Sediment Controls under General Condition 12 are required. Post-construction TSS controls under General Condition 25 are required.

NWP 37 (Emergency Watershed Protection and Rehabilitation)

Soil Erosion and Sediment Controls under General Condition 12 are required.

NWP 38 (Cleanup of Hazardous and Toxic Waste)

Soil Erosion and Sediment Controls under General Condition 12 are required.

NWP 39 (Commercial and Institutional Developments)

Soil Erosion and Sediment Controls under General Condition 12 are required. Post-construction TSS controls under General Condition 25 are required.

NWP 40 (Agricultural Activities)

Soil Erosion and Sediment Controls under General Condition 12 are required. Post-construction TSS controls under General Condition 25 are required.

NWP 41 (Reshaping Existing Drainage Ditches)

Soil Erosion and Sediment Controls under General Condition 12 are required. Post-construction TSS controls under General Condition 25 are required.

NWP 42 (Recreational Facilities)

Soil Erosion and Sediment Controls under General Condition 12 are required. Post-construction TSS controls under General Condition 25 are required.

NWP 43 (Stormwater Management Facilities)

Soil Erosion and Sediment Controls under General Condition 12 are required.

NWP 44 (Mining Activities)

Soil Erosion and Sediment Controls under General Condition 12 are required. Post-construction TSS controls under General Condition 25 are required.

NWP 45 (Repair of Uplands Damaged by Discrete Events)

Soil Erosion and Sediment Controls under General Condition 12 are required. Post-construction TSS controls under General Condition 25 are required.

NWP 46 (Discharges in Ditches)

Soil Erosion and Sediment Controls under General Condition 12 are required.

NWP 49 (Coal Remining Activities)

Soil Erosion and Sediment Controls under General Condition 12 are required. Post-construction TSS controls under General Condition 25 are required.

NWP 50 (Underground Coal Mining Activities)

Soil Erosion and Sediment Controls under General Condition 12 are required. Post-construction TSS controls under General Condition 25 are required.

NWP 51 (Land-Based Renewal Energy Generation Facilities)

Soil Erosion and Sediment Controls under General Condition 12 are required. Post-construction TSS controls under General Condition 25 are required.

NWP 52 (Water-Based Renewal Energy Generation Pilot Projects)

Soil Erosion and Sediment Controls under General Condition 12 are required. Post-construction TSS controls under General Condition 25 are required.

Attachment 2

Attaehment 2
401 Water Quality Certification Best Management Practices (BMPs) for Nationwide Permits

Below are the 401 water quality certification conditions the Texas Commission on Environmental Quality (TCEQ) added to the February 21, 2012 issuance of Nationwide Permits (NWP), as described in the Federal Register (Vol. 77, No. 34, pages 10184-10290).

Additional information regarding these conditions, including descriptions of the best management practices (BMPs), can be obtained from the TCEQ by contacting the 401 Coordinator, MC-150, P.O. Box 13087, Austin, Texas 78711-3087 or from the appropriate U.S. Army Corps of Engineers district office.

I. Erosion Control

Disturbed areas must be stabilized to prevent the introduction of sediment to adjacent wetlands or water bodies during wet weather conditions (erosion). *At least one* of the following BMPs must be maintained and remain in place until the area has been stabilized for NWPs 3, 6, 7, 12, 13, 14, 15, 17, 18, 19, 21, 22, 25, 27, 29, 30, 31, 32, 33, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 49, 50, 51, and 52. If the applicant does not choose one of the BMPs listed, an individual 401 certification is required. BMPs for NWP 52 apply only to land-based impacts from attendant features.

- o Temporary Vegetation
- o Blankets/Matting
- o Mulch
- o Sod
- o Interceptor Swale
- o Diversion Dike
- o Erosion Control Compost
- o Mulch Filter Socks
- o Compost Filter Socks

II. Scdimentation Control

Prior to project initiation, the project area must be isolated from adjaccnt wetlands and water bodies by the use of BMPs to confine sediment. Dredged material shall be placed in such a manner that prevents sediment runoff into water in the state, including wetlands. Water bodies can be isolated by the use of one or more of the required BMPs identified for sedimentation control. These BMP's must be maintained and remain in place until the dredged material is stabilized. *At least one* of the following BMPs must be maintained and remain in place until the area has been stabilized for NWPs 3, 6, 7, 12, 13, 14, 15, 17, 18, 19, 21, 22, 25, 27, 29, 30, 31, 32, 33, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 49, 50, 51, and 52. If the applicant does not choose one of the BMPs listed, an individual 401 certification is required. BMPs for NWP 52 apply only to land-based impacts from attendant features.

- o Sand Bag Berm
- o Rock Berm
- o Silt Fence
- o Hay Bale Dike
- o Triangular Filter Dike
- o Brush Berms

- o Stone Outlet Sediment Traps
- o Sediment Basins
- o Erosion Control Compost
- o Mulch Filter Socks
- o Compost Filter Socks

III. Post-Construction TSS Control

After construction has been completed and the site is stabilized, total suspended solids (TSS) loadings shall be controlled by *at least one* of the following BMPs for NWPs 12, 14, 17, 18, 21, 29, 31, 36, 39, 40, 41, 42, 44, 45, 49, 50, 51, and 52. If the applicant does not choose one of the BMPs listed, an individual 401 certification is required. BMPs for NWP 52 apply only to land-based impacts from attendant features. Runoff from bridge decks has been exempted from the requirement for post construction TSS controls.

- o Retention/Irrigation Systems
- o Constructed Wetlands
- o Extended Detention Basin
- o Wet Basins
- o Vegetative Filter Strips
- o Vegetation lined drainage ditches
- o Grassy Swales
- o Sand Filter Systems
- o Erosion Control Compost
- o Mulch Filter Socks
- o Compost Filter Socks
- o Sedimentation Chambers*

* Only to be used when there is no space available for other approved BMPs.

IV. NWP 16: Return Water from Upland Contained Disposal Areas

Effluent from an upland contained disposal area shall not exceed a TSS concentration of 300 mg/L unless a site-specific TSS limit, or a site specific correlation curve for turbidity (nephelometric turbidity units (NTU)) versus (TSS) has been approved by TCEQ.

V. NWP 29, 39, 40, 42, 43, 44, 50, 51, and 52

The Corps will copy the TCEQ on all authorizations for impacts of greater than 300 linear feet of intermittent and ephemeral streams.

Attachment 2
401 Water Quality Certification Best Management Practices (BMPs) for Nationwide Permits

VI. NWP 13 and 41

The Corps will copy the TCEQ on all authorizations for impacts greater than 500 linear feet in length of ephemeral, intermittent, perennial streams or drainage ditches.

VII. NWP 36

The Corps will copy the TCEQ on all authorizations for discharges greater than the 50 cubic yard limit or boat ramps greater than 20 feet in width.

VIII. All NWPs except NWP 3

These NWPs are not authorized for use in coastal dune swales in Texas.

Attachment 3

Attachment 3
Reference to Nationwide Permits Best Management Practices Requirements

NWP	Permit Description	Erosion Control	Sediment Control	Post Construction TSS
1	Aid to Navigation			
2	Structures in Artificial Canals			
3	Maintenance	X	X	
4	Fish and Wildlife Harvesting, Enhancement and Attraction Devices and Activities			
5	Scientific Measurement Devices			
6	Survey Activities *Trenching	X	X	
7	Outfall Structures and Associated Intake Structures	X	X	
8	Oil and Gas Structures on the Outer Continental Shelf			
9	Structures in Fleeting and Anchorage Areas			
10	Mooring Buoys			
11	Temporary Recreational Structures			
12	Utility Line Activities	X	X	X
13	Bank Stabilization	X	X	
14	Linear Transportation Projects	X	X	X
15	U.S. Coast Guard Approved Bridges	X	X	
16	Return Water From Upland Contained Disposal Areas			
17	Hydropower Projects	X	X	X
18	Minor Discharges	X	X	X
19	Minor Dredging	X	X	
20	Response Operations for Oil and Hazardous Substances			
21	Surface Coal Mining Operations	X	X	X
22	Removal of Vessels	X	X	
23	Approved Categorical Exclusions			

Attachment 3
Reference to Nationwide Permits Best Management Practices Requirements

NWP	Permit Description	Erosion Control	Sediment Control	Post Construction TSS
24	Indian Tribe or State Administered Section 404 Programs			
25	Structural Discharges	X	X	
26	[Reserved]			
27	Aquatic Habitat Restoration, Establishment, and Enhancement Activities	X	X	
28	Modifications of Existing Marinas			
29	Residential Developments	X	X	X
30	Moist Soil Management for Wildlife	X	X	
31	Maintenance of Existing Flood Control Facilities	X	X	X
32	Completed Enforcement Actions	X	X	
33	Temporary Construction, Access and Dewatering	X	X	
34	Cranberry Production Activities			
35	Maintenance Dredging of Existing Basins			
36	Boat Ramps	X	X	X
37	Emergency Watershed Protection and Rehabilitation	X	X	
38	Cleanup of Hazardous and Toxic Waste	X	X	
39	Commercial and Institutional Developments	X	X	X
40	Agricultural Activities	X	X	X
41	Reshaping Existing Drainage Ditches	X	X	X
42	Recreational Facilities	X	X	X
43	Stormwater Management Facilities	X	X	
44	Mining Activities	X	X	X
45.	Repair of Uplands Damaged by Discrete Events	X	X	X
46.	Discharges in Ditches	X	X	

Attachment 3
Reference to Nationwide Permits Best Management Practices Requirements

NWP	Permit Description	Erosion Control	Sediment Control	Post Construction TSS
47.	[Reserved]			
48.	Existing Commercial Shellfish Aquaculture Activities			
49.	Coal Remining Activities	X	X	X
50.	Underground Coal Mining Activities	X	X	X
51.	Land-Based Renewable Energy Generation Facilities	X	X	X
52.	Water-Based Renewable Energy Generation Pilot Projects	X	X	X

Attachment 4

Attachment 4
Description of BMPs

EROSION CONTROL BMPs

Temporary Vegetation

Description: Vegetation can be used as a temporary or permanent stabilization technique for areas disturbed by construction. Vegetation effectively reduces erosion in swales, stockpiles, berms, mild to medium slopes, and along roadways. Other techniques such as matting, mulches, and grading may be required to assist in the establishment of vegetation.

Materials:

- The type of temporary vegetation used on a site is a function of the season and the availability of water for irrigation.
- Temporary vegetation should be selected appropriately for the area.
- County agricultural extension agents are a good source for suggestions for temporary vegetation.
- All seed should be high quality, U.S. Dept. of Agriculture certified seed.

Installation:

- Grading must be completed prior to seeding.
- Slopes should be minimized.
- Erosion control structures should be installed.
- Seedbeds should be well pulverized, loose, and uniform.
- Fertilizers should be applied at appropriate rates.
- Seeding rates should be applied as recommended by the county agricultural extension agent.
- The seed should be applied uniformly.
- Steep slopes should be covered with appropriate soil stabilization matting.

Blankets and Matting

Description: Blankets and matting material can be used as an aid to control erosion on critical sites during the establishment period of protective vegetation. The most common uses are in channels, interceptor swales, diversion dikes, short, steep slopes, and on tidal or stream banks.
Materials:

New types of blankets and matting materials are continuously being developed. The Texas

Attachment 4
Description of BMPs

Department of Transportation (TxDOT) has defined the critical performance factors for these types of products and has established minimum performance standards which must be met for any product seeking to be approved for use within any of TxDOT's construction or maintenance activities. The products that have been approved by TxDOT are also appropriate for general construction site stabilization. TxDOT maintains a web site at http://www.txdot.gov/business/doing_business/product_evaluation/erosion_control.htm which is updated as new products are evaluated.

Installation:

- Install in accordance with the manufacturer's recommendations.
- Proper anchoring of the material.
- Prepare a friable seed bed relatively free from clods and rocks and any foreign material.
- Fertilize and seed in accordance with seeding or other type of planting plan.
- Erosion stops should extend beyond the channel liner to full design cross-section of the channel.
- A uniform trench perpendicular to line of flow may be dug with a spade or a mechanical trencher.
- Erosion stops should be deep enough to penetrate solid material or below level of ruling in sandy soils.
- Erosion stop mats should be wide enough to allow turnover at bottom of trench for stapling, while maintaining the top edge flush with channel surface.

Mulch

Description: Mulching is the process of applying a material to the exposed soil surface to protect it from erosive forces and to conserve soil moisture until plants can become established. When seeding critical sites, sites with adverse soil conditions or seeding on other than optimum seeding dates, mulch material should be applied immediately after seeding. Seeding during optimum seeding dates and with favorable soils and site conditions will not need to be mulched.

Materials:

- Mulch may be small grain straw which should be applied uniformly.
- On slopes 15 percent or greater, a binding chemical must be applied to the surface.
- Wood-fiber or paper-fiber mulch may be applied by hydroseeding.
- Mulch nettings may be used.

- Wood chips may be used where appropriate.

Installation:

Mulch anchoring should be accomplished immediately after mulch placement. This may be done by one of the following methods: peg and twine, mulch netting, mulch anchoring tool, or liquid mulch binders.

Sod

Description: Sod is appropriate for disturbed areas which require immediate vegetative covers, or where sodding is preferred to other means of grass establishment. Locations particularly suited to stabilization with sod are waterways carrying intermittent flow, areas around drop inlets or in grassed swales, and residential or commercial lawns where quick use or aesthetics are factors. Sod is composed of living plants and those plants must receive adequate care in order to provide vegetative stabilization on a disturbed area.

Materials:

- Sod should be machine cut at a uniform soil thickness.
- Pieces of sod should be cut to the supplier's standard width and length.
- Torn or uneven pads are not acceptable.
- Sections of sod should be strong enough to support their own weight and retain their size and shape when suspended from a firm grasp.
- Sod should be harvested, delivered, and installed within a period of 36 hours.

Installation:

- Areas to be sodded should be brought to final grade.
- The surface should be cleared of all trash and debris.
- Fertilize according to soil tests.
- Fertilizer should be worked into the soil.
- Sod should not be cut or laid in excessively wet or dry weather.
- Sod should not be laid on soil surfaces that are frozen.
- During periods of high temperature, the soil should be lightly irrigated.

- The first row of sod should be laid in a straight line with subsequent rows placed parallel to and butting tightly against each other.
- Lateral joints should be staggered to promote more uniform growth and strength.
- Wherever erosion may be a problem, sod should be laid with staggered joints and secured.
- Sod should be installed with the length perpendicular to the slope (on the contour).
- Sod should be rolled or tamped.
- Sod should be irrigated to a sufficient depth.
- Watering should be performed as often as necessary to maintain soil moisture.
- The first mowing should not be attempted until the sod is firmly rooted.
- Not more than one third of the grass leaf should be removed at any one cutting.

Interceptor Swale

Interceptor swales are used to shorten the length of exposed slope by intercepting runoff, prevent off-site runoff from entering the disturbed area, and prevent sediment-laden runoff from leaving a disturbed site. They may have a v-shape or be trapezoidal with a flat bottom and side slopes of 3:1 or flatter. The outflow from a swale should be directed to a stabilized outlet or sediment trapping device. The swales should remain in place until the disturbed area is permanently stabilized.

Materials:

- Stabilization should consist of a layer of crushed stone three inches thick, riprap or high velocity erosion control mats.
- Stone stabilization should be used when grades exceed 2% or velocities exceed 6 feet per second.
- Stabilization should extend across the bottom of the swale and up both sides of the channel to a minimum height of three inches above the design water surface elevation based on a 2-year, 24-hour storm.

Installation:

- An interceptor swale should be installed across exposed slopes during construction and should intercept no more than 5 acres of runoff.
- All earth removed and not needed in construction should be disposed of in an approved spoils site so that it will not interfere with the functioning of the swale or contribute to siltation in other areas of the site.

- All trees, brush, stumps, obstructions and other material should be removed and disposed of so as not to interfere with the proper functioning of the swale.

- Swales should have a maximum depth of 1.5 feet with side slopes of 3:1 or flatter. Swales should have positive drainage for the entire length to an outlet.

- When the slope exceeds 2 percent, or velocities exceed 6 feet per second (regardless of slope), stabilization is required. Stabilization should be crushed stone placed in a layer of at least 3 inches thick or may be high velocity erosion control matting. Check dams are also recommended to reduce velocities in the swales possibly reducing the amount of stabilization necessary.

- Minimum compaction for the swale should be 90% standard proctor density.

Diversion Dikes

A temporary diversion dike is a barrier created by the placement of an earthen embankment to reroute the flow of runoff to an erosion control device or away from an open, easily erodible area. A diversion dike intercepts runoff from small upland areas and diverts it away from exposed slopes to a stabilized outlet, such as a rock berm, sandbag berm, or stone outlet structure. These controls can be used on the perimeter of the site to prevent runoff from entering the construction area. Dikes are generally used for the duration of construction to intercept and reroute runoff from disturbed areas to prevent excessive erosion until permanent drainage features are installed and/or slopes are stabilized.

Materials:

- Stone stabilization (required for velocities in excess of 6 fps) should consist of riprap placed in a layer at least 3 inches thick and should extend a minimum height of 3 inches above the design water surface up the existing slope and the upstream face of the dike.

- Geotextile fabric should be a non-woven polypropylene fabric designed specifically for use as a soil filtration media with an approximate weight of 6 oz./yd^2, a Mullen burst rating of 140 psi, and having an equivalent opening size (EOS) greater than a #50 sieve.

Installation:

- Diversion dikes should be installed prior to and maintained for the duration of construction and should intercept no more than 10 acres of runoff.

- Dikes should have a minimum top width of 2 feet and a minimum height of compacted fill of 18 inches measured form the top of the existing ground at the upslopc toe to top of the dike and have side slopes of 3:1 or flatter.

- The soil for the dike should be placed in lifts of 8 inches or less and be compacted to 95 % standard proctor density.

- The channel, which is formed by the dike, must have positive drainage for its entire length to an outlet.

- When the slope exceeds 2 percent, or velocities exceed 6 feet per second (regardless of slope), stabilization is required. In situations where velocities do not exceed 6 feet per second, vegetation may be used to control erosion.

Erosion Control Compost

Description: Erosion control compost (ECC) can be used as an aid to control erosion on critical sites during the establishment period of protective vegetation. The most common uses are on steep slopes, swales, diversion dikes, and on tidal or stream banks.

Materials:

New types of erosion control compost are continuously being developed. The Texas Department of Transportation (TxDOT) has established minimum performance standards which must be met for any products seeking to be approved for use within any of TxDOT's construction or maintenance activities. Material used within any TxDOT construction or maintenance activities must meet material specifications in accordance with current TxDOT specifications. TxDOT maintains a website at http://www.txdot.gov/business/contractors_consultants/recycling/compost.htm that provides information on compost specification data.

ECC used for projects not related to TxDOT should also be of quality materials by meeting performance standards and compost specification data. To ensure the quality of compost used as an ECC, products should meet all applicable state and federal regulations, including but not limited to the United States Environmental Protection Agency (USEPA) Code of Federal Regulations (CFR), Title 40, Part 503 Standards for Class A biosolids and Texas Natural Resource Conservation Commission (now named TCEQ) Health and Safety Regulations as defined in the Texas Administration Code (TAC), Chapter 332, and all other relevant requirements for compost products outlined in TAC, Chapter 332. Testing requirements required by the TCEQ are defined in TAC Chapter 332, including Sections §332.71 Sampling and Analysis Requirements for Final Products and §332.72 Final Product Grades. Compost specification data approved by TxDOT are appropriate to use for ensuring the use of quality compost materials or for guidance.

Testing standards are dependent upon the intended use for the compost and ensures product safety, and product performance regarding the product's specific use. The appropriate compost sampling and testing protocols included in the United States Composting Council (USCC) Test Methods for the Examination of Composting and Compost (TMECC) should be conducted on compost products used for ECC to ensure that the products used will not impact public health, safety, and the environment and to promote production and marketing of quality composts that meet analytical standards. TMECC is a laboratory manual that provides protocols for the composting industry and test methods for compost analysis. TMECC provides protocols to sample, monitor, and analyze materials during all stages of the composting proccss. Numerous parameters that might be of concern in compost can be tested by following protocols or test methods listed in TMECC. TMECC information can be found at http://www.tmecc.org/tmecc/index.html. The USCC Seal of Testing Assurance (STA) program contains information regarding compost STA certification. STA program information can be found at http://tmecc.org/sta/STA_program_description.html.

Attachment 4
Description of BMPs

Installation:

- Install in accordance with current TxDOT specification.
- Use on slopes 3:1 or flatter.
- Apply a 2 inch uniform layer unless otherwise shown on the plans or as directed.
- When rolling is specified, use a light corrugated drum roller.

Mulch and Compost Filter Socks

Description: Mulch and compost filter socks (erosion control logs) are used to intercept and detain sediment laden run-off from unprotected areas. When properly used, mulch and compost filter socks can be highly effective at controlling sediment from disturbed areas. They cause runoff to pond which allows heavier solids to settle. Mulch and compost filter socks are used during the period of construction near the perimeter of a disturbed area to intercept sediment while allowing water to percolate through. The sock should remain in place until the area is permanently stabilized. Mulch and compost filter socks may be installed in construction areas and temporarily moved during the day to allow construction activity provided it is replaced and properly anchored at the end of the day. Mulch and compost filter socks may be seeded to allow for quick vegetative growth and reduction in run-off velocity.

Materials:

New types of mulch and compost filter socks are continuously being developed. The Texas Department of Transportation (TxDOT) has established minimum performance standards which must be met for any products seeking to be approved for use within any of TxDOT's construction or maintenance activities. Mulch and compost filter socks used within any TxDOT construction or maintenance activities must meet material specifications in accordance with TxDOT specification 5049. TxDOT maintains a website at http://www.txdot.gov/business/contractors_consultants/recycling/compost.htm that provides information on compost specification data.

Mulch and compost filter socks used for projects not related to TxDOT should also be of quality materials by meeting performance standards and compost specification data. To ensure the quality of compost used for mulch and compost filter socks, products should meet all applicable state and federal regulations, including but not limited to the United States Environmental Protection Agency (USEPA) Code of Federal Regulations (CFR), Title 40, Part 503 Standards for Class A biosolids and Texas Natural Resource Conservation Commission Health and Safety Regulations as defined in the Texas Administration Code (TAC), Chapter 332, and all other relevant requirements for compost products outlined in TAC, Chapter 332. Testing requirements required by the TCEQ are defined in TAC Chapter 332, including Sections §332.71 Sampling and Analysis Requirements for Final Products and §332.72 Final Product Grades. Compost specification data approved by TxDOT are appropriate to use for ensuring the use of quality compost materials or for guidance.

Testing standards are dependent upon the intended use for the compost and ensures product safety, and product performance regarding the product's specific use. The appropriate compost sampling and testing protocols included in the United States Composting Council (USCC) Test Methods for the Examination of Composting and Compost (TMECC) should be conducted on compost products used for mulch and compost filter socks to ensure that the products used will not impact public health, safety, and the environment and to promote production and marketing of quality composts that meet analytical standards. TMECC is a laboratory manual that provides protocols for the composting industry and test methods for compost analysis. TMECC provides protocols to sample, monitor, and analyze materials during all stages of the composting process. Numerous parameters that might be of concern in compost can be tested by following protocols or test methods listed in TMECC. TMECC information can be found at http://www.tmecc.org/tmecc/index.html. The USCC Seal of Testing Assurance (STA) program contains information regarding compost STA certification. STA program information can be found at http://tmecc.org/sta/STA_program_description.html.

Installation:

- Install in accordance with TxDOT Special Specification 5049.
- Install socks (erosion control logs) near the downstream perimeter of a disturbed area to intercept sediment from sheet flow.
- Secure socks in a method adequate to prevent displacement as a result of normal rain events such that flow is not allowed under the socks.
- Inspect and maintain the socks in good condition (including staking, anchoring, etc.). Maintain the integrity of the control, including keeping the socks free of accumulated silt, debris, etc., until the disturbed area has been adequately stabilized.

SEDIMENT CONTROL BMPS

Sand Bag Berm

Description: The purpose of a sandbag berm is to dctain sediment carried in runoff from disturbed areas. This objective is accomplished by intercepting runoff and causing it to pool behind the sand bag berm. Sediment carried in the runoff is deposited on the upstream side of the sand bag berm due to the rcduced flow velocity. Excess runoff volumes are allowed to flow over the top of the sand bag berm. Sand bag berms are used only during construction activities in streambeds when the contributing drainage area is between 5 and 10 acres and the slope is less than 15%, i.e., utility construction in channels, temporary channel crossing for construction equipment, etc. Plastic facing should be installed on the upstream side and the berm should be anchored to the streambed by drilling into the rock and driving in "T" posts or rebar (#5 or #6) spaced appropriately.

Attachment 4
Description of BMPs

Materials:

- The sand bag material should be polypropylene, polyethylene, polyamide or cotton burlap woven fabric, minimum unit weight 4 oz/yd 2, mullen burst strength exceeding 300 psi and ultraviolet stability exceeding 70 percent.

- The bag length should be 24 to 30 inches, width should be 16 to 18 inches and thickness should be 6 to 8 inches.

- Sandbags should be filled with coarse grade sand and free from deleterious material. All sand should pass through a No. 10 sieve. The filled bag should have an approximate weight of 40 pounds.

- Outlet pipe should be schedule 40 or stronger polyvinyl chloride (PVC) having a nominal internal diameter of 4 inches.

Installation:

- The berm should be a minimum height of 18 inches, measured from the top of the existing ground at the upslope toe to the top of the berm.

- The berm should be sized as shown in the plans but should have a minimum width of 48 inches measured at the bottom of the berm and 16 inches measured at the top of the berm.

- Runoff water should flow over the tops of the sandbags or through 4-inch diameter PVC pipes embedded below the top layer of bags.

- When a sandbag is filled with material, the open end of the sandbag should be stapled or tied with nylon or poly cord.

- Sandbags should be stacked in at least three rows abutting each other, and in staggered arrangement.

- The base of the berm should have at least 3 sandbags. These can be reduced to 2 and 1 bag in the second and third rows respectively.

- For each additional 6 inches of height, an additional sandbag must be added to each row width.

- A bypass pump-around system, or similar alternative, should be used on conjunction with the berm for effective dewatering of the work area.

Silt Fence

Description: A silt fence is a barrier consisting of geotextile fabric supported by metal posts to prevent soil and sediment loss from a site. When properly used, silt fences can be highly effective at controlling sediment from disturbed areas. They cause runoff to pond which allows heavier solids to settle. If not properly installed, silt fences are not likely to be effective. The purpose of a silt fence is to intercept and detain water-borne sediment from unprotected areas of a limited

extent. Silt fence is used during the period of construction near the perimeter of a disturbed area to intercept sediment while allowing water to percolate through. This fence should remain in place until the disturbed area is permanently stabilized. Silt fence should not be used where there is a concentration of water in a channel or drainage way. If concentrated flow occurs after installation, corrective action must be taken such as placing a rock berm in the areas of concentrated flow. Silt fencing within the site may be temporarily moved during the day to allow construction activity provided it is replaced and properly anchored to the ground at the end of the day. Silt fences on the perimeter of the site or around drainage ways should not be moved at any time.

Materials:

- Silt fence material should be polypropylene, polyethylene or polyamide woven or nonwoven fabric. The fabric width should be 36 inches, with a minimum unit weight of 4.5 oz/yd, mullen burst strength exceeding 190 lb/in 2, ultraviolet stability exceeding 70%, and minimum apparent opening size of U.S. Sieve No. 30.

- Fence posts should be made of hot rolled steel, at least 4 feet long with Tee or Y-bar cross section, surface painted or galvanized, minimum nominal weight 1.25 lb/ft 2, and Brindell hardness exceeding 140.

- Woven wire backing to support the fabric should be galvanized 2" x 4" welded wire, 12 gauge minimum.

Installation:

- Steel posts, which support the silt fence, should be installed on a slight angle toward the anticipated runoff source. Post must be embedded a minimum of 1 foot deep and spaced not more than 8 feet on center. Where water concentrates, the maximum spacing should be 6 feet.

- Lay out fencing down-slope of disturbed area, following the contour as closely as possible. The fence should be sited so that the maximum drainage area is ¼ acre/100 feet of fence.

- The toe of the silt fence should be trenched in with a spade or mechanical trencher, so that the down-slope face of the trench is flat and perpendicular to the line of flow. Where fence cannot be trenched in (e.g., pavement or rock outcrop), weight fabric flap with 3 inches of pea gravel on uphill side to prevent flow from seeping under fence.

- The trench must be a minimum of 6 inches deep and 6 inches wide to allow for the silt fence fabric to be laid in the ground and backfilled with compacted material.

- Silt fence should be securely fastened to each steel support post or to woven wire, which is in turn attached to the steel fence post. There should be a 3-foot overlap, securely fastened where ends of fabric meet.

Triangular Filter Dike

Description: The purpose of a triangular sediment filter dike is to intercept and detain water-

borne sediment from unprotected areas of limited extent. The triangular sediment filter dike is used where there is no concentration of water in a channel or other drainage way above the barrier and the contributing drainage area is less than one acre. If the uphill slope above the dike exceeds 10%, the length of the slope above the dike should be less than 50 feet. If concentrated flow occurs after installation, corrective action should be taken such as placing rock berm in the areas of concentrated flow. This measure is effective on paved areas where installation of silt fence is not possible or where vehicle access must be maintained. The advantage of these controls is the ease with which they can be moved to allow vehicle traffic and then reinstalled to maintain sediment

Materials:

- Silt fence material should be polypropylene, polyethylene or polyamide woven or nonwoven fabric. The fabric width should be 36 inches, with a minimum unit weight of 4.5 oz/yd, mullen burst strength exceeding 190 lb/in 2 , ultraviolet stability exceeding 70%, and minimum apparent opening size of U.S. Sieve No. 30.

- The dike structure should be 6 gauge 6" x 6" wire mesh folded into triangular form being eighteen (18) inches on each side.

Installation:

- The frame of the triangular sediment filter dike should be constructed of 6" x 6", 6 gauge welded wire mesh, 18 inches per side, and wrapped with geotextile fabric the same composition as that used for silt fences.

- Filter material should lap over ends six (6) inches to cover dike to dike junction; each junction should be secured by shoat rings.

- Position dike parallel to the contours, with the end of each section closely abutting the adjacent sections.

- There are several options for fastening the filter dike to the ground. The fabric skirt may be toed-in with 6 inches of compacted material, or 12 inches of the fabric skirt should extend uphill and be secured with a minimum of 3 inches of open graded rock, or with staples or nails. If these two options are not feasible the dike structure may be trenched in 4 inches.

- Triangular sediment filter dikes should be installed across exposed slopes during construction with ends of the dike tied into existing grades to prevent failure and should intercept no more than one acre of runoff.

- When moved to allow vehicular access, the dikes should be reinstalled as soon as possible, but always at the end of the workday.

Rock Berm

Description: The purpose of a rock berm is to serve as a check dam in areas of concentrated flow, to intercept sediment-laden runoff, detain the sediment and release the water in sheet flow.

The rock berm should be used when the contributing drainage area is less than 5 acres. Rock berms are used in areas where the volume of runoff is too great for a silt fence to contain. They are less effective for sediment removal than silt fences, particularly for fine particles, but are able to withstand higher flows than a silt fence. As such, rock berms are often used in areas of channel flows (ditches, gullies, etc.). Rock berms are most effective at reducing bed load in channels and should not be substituted for other erosion and sediment control measures further up the watershed.

Materials:

- The berm structure should be secured with a woven wire sheathing having maximum opening of 1 inch and a minimum wire diameter of 20 gauge galvanized and should be secured with shoat rings.

- Clean, open graded 3- to 5-inch diameter rock should be used, except in areas where high velocities or large volumes of flow are expected, where 5- to 8-inch diameter rocks may be used.

Installation:

- Lay out the woven wire sheathing perpendicular to the flow line. The sheathing should be 20 gauge woven wire mesh with 1 inch openings.

- Berm should have a top width of 2 feet minimum with side slopes being 2:1 (H:V) or flatter.

- Place the rock along the sheathing to a height not less than 18".

- Wrap the wire sheathing around the rock and secure with tie wire so that the ends of the sheathing overlap at least 2 inches, and the berm retains its shape when walked upon.

- Berm should be built along the contour at zero percent grade or as near as possible.

- The ends of the berm should be tied into existing upslope grade and the berm should be buried in a trench approximately 3 to 4 inches deep to prevent failure of the control.

Hay Bale Dike

Deseription: The purpose of a hay or straw bale dike is to intercept and detain small amounts of sediment-laden runoff from relatively small unprotected areas. Straw bales are to be used when it is not feasible to install other, more effective measures or when the construction phase is expected to last less than 3 months. Straw bales should not be used on areas where rock or other hard surfaces prevent the full and uniform anchoring of the barrier.

Materials:

Straw: The best quality straw mulch comes from wheat, oats or barley and should be free of weed and grass seed which may not be desired vegetation for the area to be protected. Straw mulch is light and therefore must be properly anchored to the ground.

Hay: This is very similar to straw with the exception that it is made of grasses and weeds and not grain stems. This form of mulch is very inexpensive and is widely available but does introduce weed and grass seed to the area. Like straw, hay is light and must be anchored.

- Straw bales should weigh a minimum of 50 pounds and should be at least 30 inches long.
- Bales should be composed entirely of vegetable matter and be free of seeds.
- Binding should be either wire or nylon string, jute or cotton binding is unacceptable. Bales should be used for not more than two months before being replaced.

Installation:

- Bales should be embedded a minimum of 4 inches and securely anchored using 2" x 2" wood stakes or 3/8" diameter rebar driven through the bales into the ground a minimum of 6 inches.
- Bales are to be placed directly adjacent to one another leaving no gap between them.
- All bales should be placed on the contour.
- The first stake in each bale should be angled toward the previously laid bale to force the bales together.

Brush Berms

Organic litter and spoil material from site clearing operations is usually burned or hauled away to be dumped elsewhere. Much of this material can be used effectively on the construction site itself. The key to constructing an efficient brush berm is in the method used to obtain and place the brush. It will not be acceptable to simply take a bulldozer and push whole trees into a pile. This method does not assure continuous ground contact with the berm and will allow uncontrolled flows under the berm.

Brush berms may be used where there is little or no concentration of water in a channel or other drainage way above the berm. The size of the drainage area should be no greater than one-fourth of an acre per 100 feet of barrier length; the maximum slope length behind the barrier should not exceed 100 feet; and the maximum slope gradient behind the barrier should be less than 50 percent (2:1).

Materials:

- The brush should consist of woody brush and branches, preferably less than 2 inches in diameter.
- The filter fabric should conform to the specifications for filter fence fabric.
- The rope should be ¼ inch polypropylene or nylon rope.

- The anchors should be 3/8-inch diameter rebar stakes that are 18-inches long.

Installation:

- Lay out the brush berm following the contour as closely as possible.
- The juniper limbs should be cut and hand placed with the vegetated part of the limb in close contact with the ground. Each subsequent branch should overlap the previous branch providing a shingle effect.
- The brush berm should be constructed in lifts with each layer extending the entire length of the berm before the next layer is started.
- A trench should be excavated 6-inches wide and 4-inches deep along the length of the barrier and immediately uphill from the barrier.
- The filter fabric should be cut into lengths sufficient to lay across the barrier from its up-slope base to just beyond its peak. The lengths of filter fabric should be draped across the width of the barrier with the uphill edge placed in the trench and the edges of adjacent pieces overlapping each other. Where joints are necessary, the fabric should be spliced together with a minimum 6-inch overlap and securely sealed.
- The trench should be backfilled and the soil compacted over the filter fabric.
- Set stakes into the ground along the downhill edge of the brush barrier, and anchor the fabric by tying rope from the fabric to the stakes. Drive the rope anchors into the ground at approximately a 45-degree angle to the ground on 6-foot centers.
- Fasten the rope to the anchors and tighten berm securely to the ground with a minimum tension of 50 pounds.
- The height of the brush berm should be a minimum of 24 inches after the securing ropes have been tightened.

Stone Outlet Sediment Traps

A stone outlet sediment trap is an impoundment created by the placement of an earthen and stone embankment to prevent soil and sediment loss from a site. The purpose of a sediment trap is to intercept sediment-laden runoff and trap the sediment in order to protect drainage ways, properties and rights of way below the sediment trap from sedimentation. A sediment trap is usually installed at points of discharge from disturbed areas. The drainage area for a sediment trap is recommended to be less than 5 acres.

Larger areas should be treated using a sediment basin. A sediment trap differs from a sediment basin mainly in the type of discharge structure. The trap should be located to obtain the maximum storage benefit from the terrain, for ease of clean out and disposal of the trapped

sediment and to minimize interference with construction activities. The volume of the trap should be at least 3600 cubic feet per acre of drainage area.

Materials:

- All aggregate should be at least 3 inches in diameter and should not exceed a volume of 0.5 cubic foot.
- The geotextile fabric specification should be woven polypropylene, polyethylene or polyamide geotextile, minimum unit weight of 4.5 oz/yd 2, mullen burst strength at least 250 lb/in 2, ultraviolet stability exceeding 70%, and equivalent opening size exceeding 40.

Installation:

- Earth Embankment: Place fill material in layers not more than 8 inches in loose depth. Before compaction, moisten or aerate each layer as necessary to provide the optimum moisture content of the material. Compact each layer to 95 percent standard proctor density. Do not place material on surfaces that are muddy or frozen. Side slopes for the embankment are to be 3:1. The minimum width of the embankment should be 3 feet.
- A gap is to be left in the embankment in the location where the natural confluence of runoff crosses the embankment line. The gap is to have a width in feet equal to 6 times the drainage area in acres.
- Geotextile Covered Rock Core: A core of filter stone having a minimum height of 1.5 feet and a minimum width at the base of 3 feet should be placed across the opening of the earth embankment and should be covered by geotextile fabric which should extend a minimum distance of 2 feet in either direction from the base of the filter stone core.
- Filter Stone Embankment: Filter stone should be placed over the geotextile and is to have a side slope which matches that of the earth embankment of 3:1 and should cover the geotextile/rock core a minimum of 6 inches when installation is complete. The crest of the outlet should be at least 1 foot below the top of the embankment.

Sediment Basins:

The purpose of a sediment basin is to intercept sediment-laden runoff and trap the sediment in order to protect drainage ways, properties and rights of way below the sediment basin from sedimentation. A sediment basin is usually installed at points of discharge from disturbed areas. The drainage area for a sediment basin is recommended to be less than 100 acres.

Sediment basins are effective for capturing and slowly releasing the runoff from larger disturbed areas thereby allowing sedimentation to take place. A sediment basin can be created where a permanent pond BMP is being constructed. Guidelines for construction of the permanent BMP should be followed, but revegetation, placement of underdrain piping, and installation of sand or other filter media should not be carried out until the site construction phase is complete.

Attachment 4
Description of BMPs

Materials:

- Riser should be corrugated metal or reinforced concrete pipe or box and should have watertight fittings or end to end connections of sections.
- An outlet pipe of corrugated metal or reinforced concrete should be attached to the riser and should have positive flow to a stabilized outlet on the downstream side of the embankment.
- An anti-vortex device and rubbish screen should be attached to the top of the riser and should be made of polyvinyl chloride or corrugated metal.

Basin Design and Construction:

- For common drainage locations that serve an area with ten or more acres disturbed at one time, a sediment basin should provide storage for a volume of runoff from a two-year, 24-hour storm from each disturbed acre drained.
- The basin length to width ratio should be at least 2:1 to improve trapping efficiency. The shape may be attained by excavation or the use of baffles. The lengths should be measured at the elevation of the riser de-watering hole.
- Place fill material in layers not more than 8 inches in loose depth. Before compaction, moisten or aerate each layer as necessary to provide the optimum moisture content of the material. Compact each layer to 95 percent standard proctor density. Do not place material on surfaces that are muddy or frozen. Side slopes for the embankment should be 3:1 (H:V).
- An emergency spillway should be installed adjacent to the embankment on undisturbed soil and should be sized to carry the full amount of flow generated by a 10-year, 3-hour storm with 1 foot of freeboard less the amount which can be carried by the principal outlet control device.
- The emergency spillway should be lined with riprap as should the swale leading from the spillway to the normal watercourse at the base of the embankment.
- The principal outlet control device should consist of a rigid vertically oriented pipe or box of corrugated metal or reinforced concrete. Attached to this structure should be a horizontal pipe, which should extend through the embankment to the toe of fill to provide a de-watering outlet for the basin.
- An anti-vortex device should be attached to the inlet portion of the principal outlet control device to serve as a rubbish screen.
- A concrete base should be used to anchor the principal outlet control device and should be sized to provide a safety factor of 1.5 (downward forces = 1.5 buoyant forces).
- The basin should include a permanent stake to indicate the sediment level in the pool and marked to indicate when the sediment occupies 50% of the basin volume (not the top of the

stake).

- The top of the riser pipe should remain open and be guarded with a trash rack and anti-vortex device. The top of the riser should be 12 inches below the elevation of the emergency spillway. The riser should be sized to convey the runoff from the 2-year, 3-hour storm when the water surface is at the emergency spillway elevation. For basins with no spillway the riser must be sized to convey the runoff from the 10-yr, 3-hour storm.

- Anti-seep collars should be included when soil conditions or length of service make piping through the backfill a possibility.

- The 48-hour drawdown time will be achieved by using a riser pipe perforated at the point measured from the bottom of the riser pipe equal to ½ the volume of the basin. This is the maximum sediment storage elevation. The size of the perforation may be calculated as follows:

$$Ao = \frac{As \times \sqrt{2h}}{Cd \times 980{,}000}$$

Where:
A_o = Area of the de-watering hole, ft 2
A_s = Surface area of the basin, ft 2
C_d = Coefficient of contraction, approximately 0.6
h = head of water above the hole, ft
Perforating the riser with multiple holes with a combined surface area equal to A_o is acceptable.

Erosion Control Compost

Description: Erosion control compost (ECC) can be used as an aid to control erosion on critical sites during the establishment period of protective vegetation. The most common uses are on steep slopes, swales, diversion dikes, and on tidal or stream banks.

Materials:

New types of erosion control compost are continuously being developed. The Texas Department of Transportation (TxDOT) has established minimum performance standards which must be met for any products seeking to be approved for use within any of TxDOT's construction or maintenance activities. Material used within any TxDOT construction or maintenance activities must meet material specifications in accordance with current TxDOT specifications. TxDOT maintains a website at http://www.txdot.gov/business/contractors_consultants/recycling/compost.htm that provides information on compost specification data.

Attachment 4
Description of BMPs

ECC used for projects not related to TxDOT should also be of quality materials by meeting performance standards and compost specification data. To ensure the quality of compost used as an ECC, products should meet all applicable state and federal regulations, including but not limited to the United States Environmental Protection Agency (USEPA) Code of Federal Regulations (CFR), Title 40, Part 503 Standards for Class A biosolids and Texas Natural Resource Conservation Commission (now named TCEQ) Health and Safety Regulations as defined in the Texas Administration Code (TAC), Chapter 332, and all other relevant requirements for compost products outlined in TAC, Chapter 332. Testing requirements required by the TCEQ are defined in TAC Chapter 332, including Sections §332.71 Sampling and Analysis Requirements for Final Products and §332.72 Final Product Grades. Compost specification data approved by TxDOT are appropriate to use for ensuring the use of quality compost materials or for guidance.

Testing standards are dependent upon the intended use for the compost and ensures product safety, and product performance regarding the product's specific use. The appropriate compost sampling and testing protocols included in the United States Composting Council (USCC) Test Methods for the Examination of Composting and Compost (TMECC) should be conducted on compost products used for ECC to ensure that the products used will not impact public health, safety, and the environment and to promote production and marketing of quality composts that meet analytical standards. TMECC is a laboratory manual that provides protocols for the composting industry and test methods for compost analysis. TMECC provides protocols to sample, monitor, and analyze materials during all stages of the composting process. Numerous parameters that might be of concern in compost can be tested by following protocols or test methods listed in TMECC. TMECC information can be found at http://www.tmecc.org/tmecc/index.html. The USCC Seal of Testing Assurance (STA) program contains information regarding compost STA certification. STA program information can be found at http://tmecc.org/sta/STA_program_description.html.

Installation:

- Install in accordance with current TxDOT specification.
- Use on slopes 3:1 or flatter.
- Apply a 2 inch uniform layer unless otherwise shown on the plans or as directed.
- When rolling is specified, use a light corrugated drum roller.

Mulch and Compost Filter Socks

Description: Mulch and compost filter socks (erosion control logs) are used to intercept and detain sediment laden run-off from unprotected areas. When properly used, mulch and compost filter socks can be highly effective at controlling sediment from disturbed areas. They cause runoff to pond which allows heavier solids to settle. Mulch and compost filter socks are used during the period of construction near the perimeter of a disturbed area to intercept sediment while allowing water to percolate through. The sock should remain in place until the area is permanently stabilized. Mulch and compost filter socks may be installed in construction areas

and temporarily moved during the day to allow construction activity provided it is replaced and properly anchored at the end of the day. Mulch and compost filter socks may be seeded to allow for quick vegetative growth and reduction in run-off velocity.

Materials:

New types of mulch and compost filter socks are continuously being developed. The Texas Department of Transportation (TxDOT) has established minimum performance standards which must be met for any products seeking to be approved for use within any of TxDOT's construction or maintenance activities. Mulch and compost filter socks used within any TxDOT construction or maintenance activities must meet material specifications in accordance with TxDOT specification 5049. TxDOT maintains a website at http://www.txdot.gov/business/contractors_consultants/recycling/compost.htm that provides information on compost specification data.

Mulch and compost filter socks used for projects not related to TxDOT should also be of quality materials by meeting performance standards and compost specification data. To ensure the quality of compost used for mulch and compost filter socks, products should meet all applicable state and federal regulations, including but not limited to the United States Environmental Protection Agency (USEPA) Code of Federal Regulations (CFR), Title 40, Part 503 Standards for Class A biosolids and Texas Natural Resource Conservation Commission Health and Safety Regulations as defined in the Texas Administration Code (TAC), Chapter 332, and all other relevant requirements for compost products outlined in TAC, Chapter 332. Testing requirements required by the TCEQ are defined in TAC Chapter 332, including Sections §332.71 Sampling and Analysis Requirements for Final Products and §332.72 Final Product Grades. Compost specification data approved by TxDOT are appropriate to use for ensuring the use of quality compost materials or for guidance.

Testing standards are dependent upon the intended use for the compost and ensures product safety, and product performance regarding the product's specific use. The appropriate compost sampling and testing protocols included in the United States Composting Council (USCC) Test Methods for the Examination of Composting and Compost (TMECC) should be conducted on compost products used for mulch and compost filter socks to ensure that the products used will not impact public health, safety, and the environment and to promote production and marketing of quality composts that meet analytical standards. TMECC is a laboratory manual that provides protocols for the composting industry and test methods for compost analysis. TMECC provides protocols to sample, monitor, and analyze materials during all stages of the composting process. Numerous parameters that might be of concern in compost can be tested by following protocols or test methods listed in TMECC. TMECC information can be found at http://www.tmecc.org/tmecc/index.html. The USCC Seal of Testing Assurance (STA) program contains information regarding compost STA certification. STA program information can be found at http://tmecc.org/sta/STA_program_description.html.

Installation:

- Install in accordance with TxDOT Special Specification 5049.

- Install socks (erosion control logs) near the downstream perimeter of a disturbed area to intercept sediment from sheet flow.
- Secure socks in a method adequate to prevent displacement as a result of normal rain events such that flow is not allowed under the socks.
- Inspect and maintain the socks in good condition (including staking, anchoring, etc.). Maintain the integrity of the control, including keeping the socks free of accumulated silt, debris, etc., until the disturbed area has been adequately stabilized.

POST-CONSTRUCTION TSS CONTROLS

Retention/Irrigation Systems

Deseription: Retention/irrigation systems refer to the capture of runoff in a holding pond, then use of the captured water for irrigation of appropriate landscape areas. Retention/irrigation systems are characterized by the capture and disposal of runoff without direct release of captured flow to receiving streams. Retention systems exhibit excellent pollutant removal but can require regular, proper maintenance. Collection of roof runoff for subsequent use (rainwater harvesting) also qualifies as a retention/irrigation practice, but should be operated and sized to provide adequate volume. This technology, which emphasizes beneficial use of stormwater runoff, is particularly appropriate for arid regions because of increasing demands on water supplies for agricultural irrigation and urban water supply.

Design Considerations: Retention/irrigation practices achieve 100% removal efficiency of total suspended solids contained within the volume of water captured. Design elements of retention/irrigation systems include runoff storage facility configuration and sizing, pump and wet well system components, basin lining, basin detention time, and physical and operational components of the irrigation system. Retention/irrigation systems are appropriate for large drainage areas with low to moderate slopes. The retention capacity should be sufficient considering the average rainfall event for the area.

Maintenance Requirements: Maintenance requirements for retention/irrigation systems include routine inspections, sediment removal, mowing, debris and litter removal, erosion control, and nuisance control.

Extended Detention Basin

Deseription: Extended detention facilities are basins that temporarily store a portion of stormwater runoff following a storm event. Extended detention basins are normally used to remove particulate pollutants and to reduce maximum runoff rates associated with development to their pre-development levels. The water quality benefits are the removal of sediment and buoyant materials. Furthermore, nutrients, heavy metals, toxic materials, and oxygen-demanding materials associated with the particles also are removed. The control of the maximum runoff rates serves to protect drainage channels below the device from erosion and to reduce downstream flooding. Although detention facilities designed for flood control have different design requirements than those used for water quality enhancement, it is possible to

achieve these two objectives in a single facility.

Design Considerations: Extended detention basins can remove approximately 75% of the total suspended solids contained within the volume of runoff captured in the basin. Design elements of extended detention basins include basin sizing, basin configuration, basin side slopes, basin lining, inlet/outlet structures, and erosion controls. Extended detention basins are appropriate for large drainage areas with low to moderate slopes. The retention capacity should be sufficient considering the average rainfall event for the area.

Maintenance Requirements: Maintenance requirements for extended detention basins include routine inspections, mowing, debris and litter removal, erosion control, structural repairs, nuisance control, and sediment removal.

Vegetative Filter Strips

Description: Filter strips, also known as vegetated buffer strips, are vegetated sections of land similar to grassy swales except they are essentially flat with low slopes, and are designed only to accept runoff as overland sheet flow. They may appear in any vegetated form from grassland to forest, and are designed to intercept upstream flow, lower flow velocity, and spread water out as sheet flow. The dense vegetative cover facilitates conventional pollutant removal through detention, filtration by vegetation, and infiltration.

Filter strips cannot treat high velocity flows, and do not provide enough storage or infiltration to effectively reduce peak discharges to predevelopment levels for design storms. This lack of quantity control favors use in rural or low-density development; however, they can provide water quality benefits even where the impervious cover is as high as 50%. The primary highway application for vegetative filter strips is along rural roadways where runoff that would otherwise discharge directly to a receiving water passes through the filter strip before entering a conveyance system. Properly designed roadway medians and shoulders make effective buffer strips. These devices also can be used on other types of development where land is available and hydraulic conditions are appropriate.

Flat slopes and low to fair permeability of natural subsoil are required for effective performance of filter strips. Although an inexpensive control measure, they are most useful in contributing watershed areas where peak runoff velocities are low as they are unable to treat the high flow velocities typically associated with high impervious cover.

Successful performance of filter strips relies heavily on maintaining shallow unconcentrated flow. To avoid flow channelization and maintain performance, a filter strip should:

- Be equipped with a level spreading device for even distribution of runoff
- Contain dense vegetation with a mix of erosion resistant, soil binding species
- Be graded to a uniform, even and relatively low slope
- Laterally traverse the contributing runoff area

Filter strips can be used upgradient from watercourses, wetlands, or other water bodies along toes and tops of slopes and at outlets of other stormwater management structures. They should be incorporated into street drainage and master drainage planning. The most important criteria for selection and use of this BMP are soils, space, and slope.

Design Considerations: Vegetative filter strips can remove approximately 85% of the total suspended solids contained within the volume of runoff captured. Design elements of vegetative filter strips include uniform, shallow overland flow across the entire filter strip area, hydraulic loading rate, inlet structures, slope, and vegetative cover. The area should be free of gullies or rills which can concentrate flow. Vegetative filter strips are appropriate for small drainage areas with moderate slopes. Other design elements include the following:

- Soils and moisture are adequate to grow relatively dense vegetative stands
- Sufficient space is available
- Slope is less than 12%
- Comparable performance to more expensive structural controls

Maintenance Requirements: Maintenance requirements for vegetative filter strips include pest management, seasonal mowing and lawn care, routine inspections, debris and litter removal, sediment removal, and grass reseeding and mulching.

Constructed Wetlands

Description: Constructed wetlands provide physical, chemical, and biological water quality treatment of stormwater runoff. Physical treatment occurs as a result of decreasing flow velocities in the wetland, and is present in the form of evaporation, sedimentation, adsorption, and/or filtration. Chemical processes include chelation, precipitation, and chemical adsorption. Biological processes include decomposition, plant uptake and removal of nutrients, plus biological transformation and degradation. Hydrology is one of the most influential factors in pollutant removal due to its effects on sedimentation, aeration, biological transformation, and adsorption onto bottom sediments.

The wetland should be designed such that a minimum amount of maintenance is required. The natural surroundings, including such things as the potential energy of a stream or flooding river, should be utilized as much as possible. The wetland should approximate a natural situation and unnatural attributes, such as rectangular shape or rigid channel, should be avoided.

Site considerations should include the water table depth, soil/substrate, and space requirements. Because the wetland must have a source of flow, it is desirable that the water table is at or near the surface. If runoff is the only source of inflow for the wetland, the water level often fluctuates and establishment of vegetation may be difficult. The soil or substrate of an artificial wetland should be loose loam to clay. A perennial baseflow must be present to sustain the artificial wetland. The presence of organic material is often helpful in increasing pollutant removal and retention. A greater amount of space is required for a wetland system than is required for a detention facility treating the same amount of area.

Design Considerations: Constructed wetlands can remove over 90% of the total suspended solids contained within the volume of runoff captured in the wetland. Design elements of constructed wetlands include wetland sizing, wetland configuration, sediment forebay, vegetation, outflow structure, depth of inundation during storm events, depth of micropools, and aeration. Constructed wetlands are appropriate for large drainage areas with low to moderate slopes.

Maintenance Requirements: Maintenance requirements for constructed wetlands include mowing, routine inspections, debris and litter removal, erosion control, nuisance control, structural repairs, sediment removal, harvesting, and maintenance of water levels.

Wet Basins

Description: Wet basins are runoff control facilities that maintain a permanent wet pool and a standing crop of emergent littoral vegetation. These facilities may vary in appearance from natural ponds to enlarged, bermed (manmade) sections of drainage systems and may function as online or offline facilities, although offline configuration is preferable. Offline designs can prevent scour and other damage to the wet pond and minimize costly outflow structure elements needed to accommodate extreme runoff events.

During storm events, runoff inflows displace part or all of the existing basin volume and are retained and treated in the facility until the next storm event. The pollutant removal mechanisms are settling of solids, wetland plant uptake, and microbial degradation. When the wet basin is adequately sized, pollutant removal performance can be excellent, especially for the dissolved fraction. Wet basins also help provide erosion protection for the receiving channel by limiting peak flows during larger storm events. Wet basins are often perceived as a positive aesthetic element in a community and offer significant opportunity for creative pond configuration and landscape design. Participation of an experienced wetland designer is suggested. A significant potential drawback for wet ponds in arid climates is that the contributing watershed for these facilities is often incapable of providing an adequate water supply to maintain the permanent pool, especially during the summer months. Makeup water (i.e., well water or municipal drinking water) is sometimes used to supplement the rainfall/runoff process, especially for wet basin facilities treating watersheds that generate insufficient runoff.

Design Considerations: Wet basins can remove over 90% of the total suspended solids contained within the volume of runoff captured in the basin. Design elements of wet basins include basin sizing, basin configuration, basin side slopes, sediment forebay, inflow and outflow structures, vegetation, depth of permanent pool, aeration, and erosion control. Wet basins are appropriate for large drainage areas with low to moderate slopes.

Maintenance Requirements: Maintenance requirements for wet basins include mowing, routine inspections, debris and litter removal, erosion control, nuisance control, structural repairs, sediment removal, and harvesting.

Attachment 4
Description of BMPs

Grassy Swales

Grassy swales are vegetated channels that convey stormwater and remove pollutants by filtration through grass and infiltration through soil. They require shallow slopes and soils that drain well. Pollutant removal capability is related to channel dimensions, longitudinal slope, and type of vegetation. Optimum design of these components will increase contact time of runoff through the swale and improve pollutant removal rates.

Grassy swales are primarily stormwater conveyance systems. They can provide sufficient control under light to moderate runoff conditions, but their ability to control large storms is limited. Therefore, they are most applicable in low to moderate sloped areas or along highway medians as an alternative to ditches and curb and gutter drainage. Their performance diminishes sharply in highly urbanized settings, and they are generally not effective enough to receive construction stage runoff where high sediment loads can overwhelm the system. Grassy swales can be used as a pretreatment measure for other downstream BMPs, such as extended detention basins. Enhanced grassy swales utilize check dams and wide depressions to increase runoff storage and promote greater settling of pollutants.

Grassy swales can be more aesthetically pleasing than concrete or rock-lined drainage systems and are generally less expensive to construct and maintain. Swales can slightly reduce impervious area and reduce the pollutant accumulation and delivery associated with curbs and gutters. The disadvantages of this technique include the possibility of erosion and channelization over time, and the need for more right-of-way as compared to a storm drain system. When properly constructed, inspected, and maintained, the life
expectancy of a swale is estimated to be 20 years.

Design Considerations:

- Comparable performance to wet basins
- Limited to treating a few acres
- Availability of water during dry periods to maintain vegetation
- Sufficient available land area

The suitability of a swale at a site will depend on land use, size of the area serviced, soil type, slope, imperviousness of the contributing watershed, and dimensions and slope of the swale system. In general, swales can be used to serve areas of less than 10 acres, with slopes no greater than 5 %. The seasonal high water table should be at least 4 feet below the surface. Use of natural topographic lows is encouraged, and natural drainage courses should be regarded as significant local resources to be kept in use.

Maintenance Requirements:

Research in the Austin area indicates that vegetated controls are effective at removing pollutants even when dormant. Therefore, irrigation is not required to maintain growth during dry periods, but may be necessary only to prevent the vegetation from dying.

Attachment 4
Description of BMPs

Vegetation Lined Drainage Ditches

Vegetation lined drainage ditches are similar to grassy swales. These drainage ditches are vegetated channels that convey storm water and remove pollutants by filtration through grass and infiltration through soil. They require soils that drain well. Pollutant removal capability is related to channel dimensions, longitudinal slope, and type of vegetation. Optimum design of these components will increase contact time of runoff through the ditch and improve pollutant removal rates. Vegetation lined drainage ditches are primarily storm water conveyance systems. They have vegetation lined in the low flow channel and may include vegetated shelves.

Vegetation in drainage ditches reduces erosion and removes pollutants by lowering water velocity over the soil surface, binding soil particles with roots, and by filtration through grass and infiltration through soil. Vegetation lined drainage ditches can be used where:

- A vegetative lining can provide sufficient stability for the channel grade by increasing maximum permissible velocity

- Slopes are generally less than 5%, with protection from sheer stress as needed through the use of BMPs, such as erosion control blankets

- Site conditions required to establish vegetation, i.e. climate, soils, topography, are present

Design Criteria: The suitability of a vegetation lined drainage ditch at a site will depend on land use, size of the area serviced, soil type, slope, imperviousness of the contributing watershed, and dimensions and slope of the ditch system. The hydraulic capacity of the drainage ditch and other elements such as erosion, siltation, and pollutant removal capability, must be taken into consideration. Use of natural topographic lows is encouraged, and natural drainage courses should be regarded as significant local resources to be kept in use. Other items to consider include the following:

- Capacity, cross-section shape, side slopes, and grade

- Select appropriate native vegetation

- Construct in stable, low areas to conform with the natural drainage system. To reduce erosion potential, design the channel to avoid sharp bends and steep grades.

- Design and build drainage ditches with appropriate scour and erosion protection. Surface water should be able to enter over the vegetated banks without erosion occurring.

- BMPs, such as erosion control blankets, may need to be installed at the time of seeding to provide stability until the vegetation is fully established. It may also be necessary to divert water from the channel until vegetation is established or to line the channel with sod.

- Vegetated ditches must not be subject to sedimentation from disturbed areas.

• Sediment traps may be needed at channel inlets to prevent entry of muddy runoff and channel sedimentation.

- Availability of water during dry periods to maintain vegetation
- Sufficient available land area

Maintenance:

During establishment, vegetation lined drainage ditches should be inspected, repaired, and vegetation reestablished if necessary. After the vegetation has become established, the ditch should be checked periodically to determine if the channel is withstanding flow velocities without damage. Check the ditch for debris, scour, or erosion and immediately make repairs if needed. Check the channel outlet and all road crossings for bank stability and evidence of piping or scour holes and make repairs immediately. Remove all significant sediment accumulations to maintain the designed carrying capacity. Keep the vegetation in a healthy condition at all times, since it is the primary erosion protection for the channel. Vegetation lined drainage ditches should be seasonally maintained by mowing or irrigating, depending on the vegetation selected. The long-term management of ditches as stable, vegetated, "natural" drainage systems with native vegetation buffers is highly recommended due to the inherent stability offered by grasses, shrubs, trees, and other vegetation.

Research in the Austin area indicates that vegetated controls are effective at removing pollutants even when dormant. Therefore, irrigation is not required to maintain growth during dry periods, but may be necessary only to prevent the vegetation from dying.

Sand Filter Systems

The objective of sand filters is to remove sediment and the pollutants from the first flush of pavement and impervious area runoff. The filtration of nutrients, organics, and coliform bacteria is enhanced by a mat of bacterial slime that develops during normal operations. One of the main advantages of sand filters is their adaptability; they can be used on areas with thin soils, high evaporation rates, low-soil infiltration rates, in limited-space areas, and where groundwater is to be protected.

Since their original inception in Austin, Texas, hundreds of intermittent sand filters have been implemented to treat stormwater runoff. There have been numerous alterations or variations in the original design as engineers in other jurisdictions have improved and adapted the technology to meet their specific requirements. Major types include the Austin Sand Filter, the District of Columbia Underground Sand Filter, the Alexandria Dry Vault Sand Filter, the Delaware Sand Filter, and peat-sand filters which are adapted to provide a sorption layer and vegetative cover to various sand filter designs .

Design Considerations:

- Appropriate for space-limited areas

- Applicable in arid climates where wet basins and constructed wetlands are not appropriate
- High TSS removal efficiency

Cost Considerations:

Filtration Systems may require less land than some other BMPs, reducing the land acquisition cost; however the structure itself is one of the more expensive BMPs. In addition, maintenance cost can be substantial.

Erosion Control Compost

Description: Erosion control compost (ECC) can be used as an aid to control erosion on critical sites during the establishment period of protective vegetation. The most common uses are on steep slopes, swales, diversion dikes, and on tidal or stream banks.

Materials:

New types of erosion control compost are continuously being developed. The Texas Department of Transportation (TxDOT) has established minimum performance standards which must be met for any products seeking to be approved for use within any of TxDOT's construction or maintenance activities. Material used within any TxDOT construction or maintenance activities must meet material specifications in accordance with current TxDOT specifications. TxDOT maintains a website at http://www.txdot.gov/business/contractors_consultants/recycling/compost.htm that provides information on compost specification data.

ECC used for projects not related to TxDOT should also be of quality materials by meeting performance standards and compost specification data. To ensure the quality of compost used as an ECC, products should meet all applicable state and federal regulations, including but not limited to the United States Environmental Protection Agency (USEPA) Code of Federal Regulations (CFR), Title 40, Part 503 Standards for Class A biosolids and Texas Natural Resource Conservation Commission (now named TCEQ) Health and Safety Regulations as defined in the Texas Administration Code (TAC), Chapter 332, and all other relevant requirements for compost products outlined in TAC, Chapter 332. Testing requirements required by the TCEQ are defined in TAC Chapter 332, including Sections §332.71 Sampling and Analysis Requirements for Final Products and §332.72 Final Product Grades. Compost specification data approved by TxDOT are appropriate to use for ensuring the use of quality compost materials or for guidance.
Testing standards are dependent upon the intended use for the compost and ensures product safety, and product performance regarding the product's specific use. The appropriate compost sampling and testing protocols included in the United States Composting Council (USCC) Test Methods for the Examination of Composting and Compost (TMECC) should be conducted on compost products used for ECC to ensure that the products used will not impact public health, safety, and the environment and to promote production and marketing of quality composts that meet analytical standards. TMECC is a laboratory manual that provides protocols for the composting industry and test methods for compost analysis. TMECC provides protocols to sample, monitor, and analyze materials during all stages of the composting process. Numerous

parameters that might be of concern in compost can be tested by following protocols or test methods listed in TMECC. TMECC information can be found at http://www.tmecc.org/tmecc/index.html. The USCC Seal of Testing Assurance (STA) program contains information regarding compost STA certification. STA program information can be found at http://tmecc.org/sta/STA_program_description.html.

Installation:

- Install in accordance with current TxDOT specification.
- Use on slopes 3:1 or flatter.
- Apply a 2 inch uniform layer unless otherwise shown on the plans or as directed.
- When rolling is specified, use a light corrugated drum roller.

Muleh and Compost Filter Socks

Description: Mulch and compost filter socks (erosion control logs) are used to intercept and detain sediment laden run-off from unprotected areas. When properly used, mulch and compost filter socks can be highly effective at controlling sediment from disturbed areas. They cause runoff to pond which allows heavier solids to settle. Mulch and compost filter socks are used during the period of construction near the perimeter of a disturbed area to intercept sediment while allowing water to percolate through. The sock should remain in place until the area is permanently stabilized. Mulch and compost filter socks may be installed in construction areas and temporarily moved during the day to allow construction activity provided it is replaced and properly anchored at the end of the day. Mulch and compost filter socks may be seeded to allow for quick vegetative growth and reduction in run-off velocity.

Materials:

New types of mulch and compost filter socks are continuously being developed. The Texas Department of Transportation (TxDOT) has established minimum performance standards which must be met for any products seeking to be approved for use within any of TxDOT's construction or maintenance activities. Mulch and compost filter socks used within any TxDOT construction or maintenance activities must meet material specifications in accordance with TxDOT specification 5049. TxDOT maintains a website at http://www.txdot.gov/business/contractors_consultants/recycling/compost.htm that provides information on compost specification data.

Mulch and compost filter socks used for projects not related to TxDOT should also be of quality materials by meeting performance standards and compost specification data. To ensure the quality of compost used for mulch and compost filter socks, products should meet all applicable state and federal regulations, including but not limited to the United States Environmental Protection Agency (USEPA) Code of Federal Regulations (CFR), Title 40, Part 503 Standards for Class A biosolids and Texas Natural Resource Conservation Commission Health and Safety Regulations as defined in the Texas Administration Code (TAC), Chapter 332, and all other

relevant requirements for compost products outlined in TAC, Chapter 332. Testing requirements required by the TCEQ are defined in TAC Chapter 332, including Sections §332.71 Sampling and Analysis Requirements for Final Products and §332.72 Final Product Grades. Compost specification data approved by TxDOT are appropriate to use for ensuring the use of quality compost materials or for guidance.

Testing standards are dependent upon the intended use for the compost and ensures product safety, and product performance regarding the product's specific use. The appropriate compost sampling and testing protocols included in the United States Composting Council (USCC) Test Methods for the Examination of Composting and Compost (TMECC) should be conducted on compost products used for mulch and compost filter socks to ensure that the products used will not impact public health, safety, and the environment and to promote production and marketing of quality composts that meet analytical standards. TMECC is a laboratory manual that provides protocols for the composting industry and test methods for compost analysis. TMECC provides protocols to sample, monitor, and analyze materials during all stages of the composting process. Numerous parameters that might be of concern in compost can be tested by following protocols or test methods listed in TMECC. TMECC information can be found at http://www.tmecc.org/tmecc/index.html. The USCC Seal of Testing Assurance (STA) program contains information regarding compost STA certification. STA program information can be found at http://tmecc.org/sta/STA_program_description.html.

Installation:

- Install in accordance with TxDOT Special Specification 5049.
- Install socks (erosion control logs) near the downstream perimeter of a disturbed area to intercept sediment from sheet flow.
- Secure socks in a method adequate to prevent displacement as a result of normal rain events such that flow is not allowed under the socks.
- Inspect and maintain the socks in good condition (including staking, anchoring, etc.). Maintain the integrity of the control, including keeping the socks free of accumulated silt, debris, etc., until the disturbed area has been adequately stabilized.

Sedimentation Chambers (only to be used when there is no space available for other approved BMP's)

Deseription: Sedimentation chambers are stormwater treatment structures that can be used when space is limited such as urban settings. These structures are often tied into stormwater drainage systems for treatment of stormwater prior to entering state waters. The water quality benefits are the removal of sediment and buoyant materials. These structures are not designed as a catch basin or detention basin and not typically used for floodwater attenuation.

Design Considerations: Average rainfall and surface area should be considered when following manufacturer's recommendations for chamber sizing and/or number of units needed to achieve effective TSS removal. If properly sized, 50-80% removal of TSS can be expected.

Attachment 4
Description of BMPs

Maintenance Requirements: Maintenance requirements include routine inspections, sediment, debris and litter removal, erosion control and nuisance control.

PERMIT COMPLIANCE CERTIFICATION

Permit Number:

Name of Permittee:

Date of Issuance:

Upon completion of the activity authorized by this permit and any mitigation required by the permit, sign this certification and return it to the following address:

Regulatory Branch
CESWF-PER-R
U.S. Army Corps of Engineers
P.O. Box 17300
Fort Worth, Texas 76102-0300

Please note that your permitted activity is subject to a compliance inspection by a U.S. Army Corps of Engineers representative. If you fail to comply with this permit you are subject to permit suspension, modification, or revocation.

I hereby certify that the work authorized by the above referenced permit was completed in accordance with the terms and conditions of the said permit, and required mitigation was completed in accordance with the permit conditions.

_____ _____

Signature of Permittee Date

TEXAS HISTORICAL COMMISSION
real places telling real stories

January 31, 2014

W. Nicholas Trierweiler, Ph.D.
AmaTerra Environmental
4009 Banister Lane, Suite 300
Austin, TX 78704

Re: Project review under the Antiquities Code of Texas
Final Report: *Cultural Resource Survey of the Proposed Tarrant Regional Water District/City of Dallas Integrated Pipeline Project in Tarrant, Johnson, Ellis, Navarro, Henderson, and Anderson Counties, and Expansion of the Kennedale Balancing Reservoir in Tarrant County, Texas*
Texas Antiquities Permit #5826
COMPLETED PERMIT

Dear Colleague:

Thank you for your correspondence describing the above referenced project. This letter presents the comments of the Executive Director of the Texas Historical Commission, the state agency responsible for administering the Antiquities Code of Texas.

The Archeology Division is in receipt of the final report, a completed *Abstracts in Texas Contract Archeology* form, and a copy of the report on a tagged PDF CD for the above referenced permit. The submission of the final report, abstract form, and CD demonstrates completion of your permit requirements under Permit #5826.

Thank you for your cooperation in this state review process, and for your efforts to preserve the irreplaceable heritage of Texas. **If you have any questions concerning our review or if we can be of further assistance, please contact Lillie Thompson at 512/463-1858.**

Sincerely,

for
Mark Wolfe
Executive Director

MW/lft

RESOLUTION AUTHORIZING THE ISSUANCE, SALE, AND DELIVERY OF TARRANT REGIONAL WATER DISTRICT, A WATER CONTROL AND IMPROVEMENT DISTRICT, WATER TRANSMISSION FACILITIES CONTRACT REVENUE BONDS (CITY OF DALLAS PROJECT), SERIES 2015, PLEDGING REVENUES FOR THE PAYMENT OF THE BONDS, AND AUTHORIZING OTHER INSTRUMENTS AND PROCEDURES RELATING THERETO

THE STATE OF TEXAS §
COUNTY OF TARRANT §
TARRANT REGIONAL WATER DISTRICT,
A WATER CONTROL AND IMPROVEMENT DISTRICT §

WHEREAS, Tarrant Regional Water District, a Water Control and Improvement District, (formerly known as "Tarrant County Water Control and Improvement District Number One") (the "Issuer" or "District") is a political subdivision of the State of Texas, being a conservation and reclamation district created and functioning under Article 16, Section 59, of the Texas Constitution, pursuant to the general laws of the State of Texas, including Chapters 49 and 51, Texas Water Code, and pursuant to the provisions of Chapter 268, Acts of 1957, 55th Legislature of Texas, Regular Session, as amended (collectively, the "District Act"); and

WHEREAS, a Water Transmission Facilities Financing Agreement, dated November 16, 2010 (the "Contract"), has been duly executed by the Issuer and the City of Dallas, Texas (the "City"), with respect to the acquisition, construction, and financing of an integrated pipeline project (as defined therein and as used herein, the "Project").

WHEREAS, the Issuer will authorize the Series 2015 Bonds (hereinafter defined) pursuant to the Contract, the District Act, and other applicable laws; and

WHEREAS, by adoption of its Resolution Approving an Application for Financial Assistance, dated _____, 2015, the Texas Water Development Board ("TWDB") has agreed to purchase the Issuer's hereinafter authorized bonds; and

WHEREAS, the meeting was open to the public and public notice of the time, place and purpose of said meeting was given pursuant to Chapter 551, Texas Government Code.

THEREFORE, BE IT RESOLVED BY THE BOARD OF DIRECTORS OF TARRANT REGIONAL WATER DISTRICT, A WATER CONTROL AND IMPROVEMENT DISTRICT, THAT:

Section 1. AMOUNT AND PURPOSE OF THE BONDS. The bond or bonds of the Issuer are hereby authorized to be issued and delivered, in one or more series, in an aggregate principal amount not to exceed $140,000,000, and in the manner hereinafter provided, for the purpose of obtaining funds to (i) pay for design, acquisition, and construction costs related to the Dallas Project Component (as defined in the Contract) of the Project, (ii) fund a reserve fund for the Series 2015 Bonds, and (iii) pay costs of issuance of the Series 2015 Bonds.

Section 2. DESIGNATION OF THE BONDS. Each bond issued pursuant to this Resolution shall be designated: "TARRANT REGIONAL WATER DISTRICT, A WATER CONTROL AND IMPROVEMENT DISTRICT, WATER TRANSMISSION FACILITIES CONTRACT REVENUE BOND (CITY OF DALLAS PROJECT), SERIES 2015." Initially there shall be issued, sold, and delivered hereunder a single fully registered bond, without interest coupons, payable in installments of principal (the "Initial Bond"), but the Initial Bond may be assigned and transferred and/or converted into and exchanged for a like aggregate amount of fully registered bonds, without interest coupons, having serial maturities, and in the denomination or denominations of $5,000 or any integral multiple of $5,000, all in the manner hereinafter provided. The term "Series 2015 Bonds" as used in this Resolution shall mean and include collectively the Initial Bond and all substitute bonds exchanged therefor, as well as all other substitute bonds and replacement bonds issued pursuant hereto, and the term "Series 2015 Bond" shall mean any of the Series 2015 Bonds.

Section 3. INITIAL DATE, DENOMINATION, NUMBER, MATURITIES, INITIAL REGISTERED OWNER, AND CHARACTERISTICS OF THE INITIAL BOND. (a) The Initial Bond is hereby authorized to be issued, sold, and delivered hereunder as a single fully registered Bond, without interest coupons, dated _____, 2015, in the denomination and aggregate principal amount of $_____, numbered TR-1, payable in annual installments of principal to the initial registered owner thereof, to-wit: Texas Water Development Board or to the registered assignee or assignees of said Initial Bond or any portion or portions thereof (in each case, the "registered owner"), with the annual installments of principal of the Initial Bond to be payable on the dates, respectively, and in the principal amounts, respectively, stated in the FORM OF INITIAL BOND set forth in this Resolution.

(b) The Initial Bond (i) may be prepaid or paid on the respective scheduled due dates of installments of principal thereof, (ii) may be assigned and transferred, (iii) may be converted and exchanged for other bonds, (iv) shall have the characteristics, and (v) shall be signed and sealed, and the principal of and interest on the Initial Bond shall be payable, all as provided, and in the manner required or indicated, in the FORM OF INITIAL BOND set forth in this Resolution.

Section 4. INTEREST. The unpaid principal balance of the Initial Bond shall bear interest from the date of delivery (the "Issuer Date") of the Initial Bond to the TWDB to the respective scheduled due dates, or to the respective dates of prepayment or redemption, of the installments of principal of the Initial Bond, and such interest shall be payable in the manner, at the rates, and on the dates, respectively, as provided in the FORM OF INITIAL BOND, set forth in this Resolution.

Section 5. FORM OF INITIAL BOND. The form of the Initial Bond, including the form of Registration Certificate of the Comptroller of Public Accounts of the State of Texas to be endorsed on the Initial Bond, shall be substantially as fol1ows:

FORM OF INITIAL BOND

NO. TR-1 $_____

UNITED STATES OF AMERICA
STATE OF TEXAS

TARRANT REGIONAL WATER DISTRICT,
A WATER CONTROL AND IMPROVEMENT DISTRICT,
WATER TRANSMISSION FACILITIES CONTRACT REVENUE BOND
(CITY OF DALLAS PROJECT),
SERIES 2015

TARRANT REGIONAL WATER DISTRICT, A WATER CONTROL AND IMPROVEMENT DISTRICT (the "Issuer"), being a political subdivision of the State of Texas, hereby promises to pay to TEXAS WATER DEVELOPMENT BOARD (the "TWDB") or to the registered assignee or assignees of this Bond or any portion or portions hereof (in each case, the "registered owner") the aggregate principal amount of _____ _____ and __/100 Dollars ($_____) in annual installments of principal due and payable on September 1 in each of the years, in the respective principal amounts, and bearing interest at the respective interest rates, as set forth in the following schedule:

Year	Principal Amount	Interest Rates	Year	Principal Amount	Interest Rates
	$	%		$	%

Interest will be payable, calculated on the basis of a 360-day year composed of twelve 30-day months, from the date of initial delivery of this Bond to the TWDB, on the balance of each such installment of principal, with said interest being payable semiannually on each March 1 and September 1, commencing _____, while this Bond or any portion hereof is outstanding and unpaid.

THE INSTALLMENTS OF PRINCIPAL OF AND THE INTEREST ON this Bond are payable in lawful money of the United States of America, without exchange or collection charges. The installments of principal and the interest on this Bond are payable to the registered owner hereof through the services of BOKF, NA dba BANK OF TEXAS, DALLAS, TEXAS, which is the "Paying Agent/Registrar" for this Bond. Payment of all principal of and interest on this Bond shall be made by the Paying Agent/Registrar to the registered owner hereof on each principal and/or interest payment date by check, dated as of such date, drawn by the Paying Agent/Registrar on, and payable solely from, funds of the Issuer required by the resolution authorizing the issuance of this Bond (the "Bond Resolution") to be on deposit with the Paying Agent/Registrar for such purpose as hereinafter provided; and such check shall be sent by the Paying Agent/Registrar by United States mail, first-class postage prepaid, on each such principal and/or interest payment date, to the registered owner hereof, at the address of the registered owner, as it appeared at the close of business on the 15th day of the month next preceding each such date (the "Record Date") on the Registration Books kept by the Paying Agent/ Registrar, as hereinafter described; provided that, if the TWDA

is the registered owner of this Bond, at the option of the TWDB and at the expense of the Issuer, such payment shall be made by wire transfer pursuant to written directions of the TWDB. The Issuer covenants with the registered owner of this Bond that on or before each principal and/or interest payment date for this Bond it will make available to the Paying Agent/Registrar, from the "Interest and Redemption Fund" created by the Bond Resolution, the amounts required to provide for the payment, in immediately available funds, of all principal of and interest on this Bond, when due.

IF THE DATE for the payment of the principal of or interest on this Bond shall be a Saturday, Sunday, a legal holiday, or a day on which banking institutions in the city where the Paying Agent/Registrar is located are authorized by law or executive order to close, then the date for such payment shall be the next succeeding day which is not such a Saturday, Sunday, legal holiday, or day on which banking institutions are authorized to close; and payment on such date shall have the same force and effect as if made on the original date payment was due.

THIS BOND has been authorized in accordance with the Constitution and laws of the State of Texas in the principal amount of $_____, for the purpose of obtaining funds to (i) pay for design, acquisition, and construction costs related to the Dallas Project Component of the Project, as such terms are defined in the Bond Resolution, consisting generally of a portion of the share of the City of Dallas, Texas (the "City") of the costs of an integrated pipeline to serve the City and the Issuer, (ii) fund a reserve fund for this Bond, and (iii) pay costs of issuance of this Bond.

ON _____ 1, ____, or any date thereafter, the unpaid installments of principal of this Bond may be prepaid or redeemed prior to their scheduled due dates, at the option of the Issuer, with funds derived from any available source, as a whole, or in part, and, if in part, the Issuer shall select and designate the installment or installment of principal, and the amount that is to be redeemed, and if less than a whole principal installment is to be called, the Issuer shall direct the Paying Agent/Registrar to call by lot or other customary method of random selection the portion of the principal installment to be redeemed (only in an integral multiple of $5,000), at the redemption price of the principal amount to be prepaid or redeemed, plus accrued interest to the date fixed for prepayment or redemption.

AT LEAST 30 days prior to the date fixed for any such prepayment or redemption a written notice of such prepayment or redemption shall be mailed by the Paying Agent/Registrar to the registered owner hereof. By the date fixed for any such prepayment or redemption due provision shall be made by the Issuer with the Paying Agent/Registrar for the payment of the required prepayment or redemption price for this Bond or the portion hereof which is to be so prepaid or redeemed, plus accrued interest thereon to the date fixed for prepayment or redemption. If such written notice of prepayment or redemption is given, and if due provision for such payment is made, all as provided above, this Bond, or the portion thereof which is to be so prepaid or redeemed, thereby automatically shall be treated as prepaid or redeemed prior to its scheduled due date, and shall not bear interest after the date fixed for its prepayment or redemption, and shall not be regarded as being outstanding except for the right of the registered owner to receive the prepayment or redemption price plus accrued interest to the date fixed for prepayment or redemption from the Paying Agent/Registrar out of the funds provided for such payment. The Paying Agent/Registrar shall record in the Registration Books all such prepayments or redemptions of principal of this Bond or any portion hereof.

THIS BOND, to the extent of the unpaid or unredeemed principal balance hereof, or any unpaid and unredeemed portion hereof in any integral multiple of $5,000, may be assigned by the initial registered owner hereof and shall be transferred only in the Registration Books of the Issuer kept by the Paying Agent/Registrar acting in the capacity of registrar for the Bonds, upon the terms and conditions set forth in the Bond Resolution. Among other requirements for such transfer, this Bond must be presented and surrendered to the Paying Agent/ Registrar for cancellation, together with proper instruments of assignment, in form and with guarantee of signatures satisfactory to the Paying Agent/Registrar, evidencing assignment by the initial registered owner of this Bond, or any portion or portions hereof in any integral multiple of $5,000, to the assignee or assignees in whose name or names this Bond or any such portion or portions hereof is or are to be transferred and registered. Any instrument or instruments of assignment satisfactory to the Paying Agent/Registrar may be used to evidence the assignment of this Bond or any such portion or portions hereof by the initial registered owner hereof. A new bond or bonds payable to such assignee or assignees (which then will be the new registered owner or owners of such new Bond or Bonds) or to the initial registered owner as to any portion of this Bond which is not being assigned and transferred by the initial registered owner, shall be delivered by the Paying Agent/Registrar in conversion of and exchange for this Bond or any portion or portions hereof, but solely in the form and manner as provided in the next paragraph hereof for the conversion and exchange of this Bond or any portion hereof. The registered owner of this Bond shall be deemed and treated by the Issuer and the Paying Agent/Registrar as the absolute owner hereof for all purposes, including payment and discharge of liability upon this Bond to the extent of such payment, and the Issuer and the Paying Agent/Registrar shall not be affected by any notice to the contrary.

AS PROVIDED above and in the Bond Resolution, this Bond, to the extent of the unpaid or unredeemed principal balance hereof, may be converted into and exchanged for a like aggregate principal amount of fully registered bonds, without interest coupons, payable to the assignee or assignees duly designated in writing by the initial registered owner hereof, or to the initial registered owner as to any portion of this Bond which is not being assigned and transferred by the initial registered owner, in any denomination or denominations in any integral multiple of $5,000 (subject to the requirement hereinafter stated that each substitute bond issued in exchange for any portion of this Bond shall have a single stated principal maturity date), upon surrender of this Bond to the Paying Agent/Registrar for cancellation, all in accordance with the form and procedures set forth in the Bond Resolution. If this Bond or any portion hereof is assigned and transferred or converted each bond issued in exchange for any portion hereof shall have a single stated principal maturity date corresponding to the due date of the installment of principal of this Bond or portion hereof for which the substitute bond is being exchanged, and shall bear interest at the rate applicable to and borne by such installment of principal or portion thereof. Such bonds, respectively, shall be subject to redemption prior to maturity on the same dates and for the same prices as the corresponding installment of principal of this Bond or portion hereof for which they are being exchanged. No such bond shall be payable in installments, but shall have only one stated principal maturity date. AS PROVIDED IN THE BOND RESOLUTION, THIS BOND IN ITS PRESENT FORM MAY BE ASSIGNED AND TRANSFERRED OR CONVERTED ONCE ONLY, and to one or more assignees, but the bonds issued and delivered in exchange for this Bond or any portion hereof may be assigned and transferred, and converted, subsequently, as provided in the Bond Resolution. The Issuer shall pay the Paying Agent/Registrar's standard or customary fees and charges for transferring, converting, and exchanging this Bond or any portion thereof, but the one requesting such transfer, conversion, and exchange shall pay any taxes or governmental charges required to be paid with respect thereto. The Paying Agent/Registrar shall not be required to make any such assignment, conversion, or exchange (i) during the period commencing with the close of business on any Record Date and ending with the opening of business on the next following principal or interest payment date, or, (ii) with respect to any Bond or portion thereof called for prepayment or redemption prior to maturity, within 45 days prior to its prepayment or redemption date.

IN THE EVENT any Paying Agent/Registrar for this Bond is changed by the Issuer, resigns, or otherwise ceases to act as such, the Issuer has covenanted in the Bond Resolution that it promptly will appoint a competent and legally qualified substitute therefor, and promptly will cause written notice thereof to be mailed to the registered owner of this Bond.

IT IS HEREBY certified, recited, and covenanted that this Bond has been duly and validly authorized, issued, and delivered; that all acts, conditions, and things required or proper to be performed, exist, and be done precedent to or in the authorization, issuance, and delivery of this Bond have been performed, existed, and been done in accordance with law; that this Bond and the interest thereon are special obligations of the Issuer which, together with other outstanding parity revenue bonds of the Issuer, are payable from and secured by a first lien on and pledge of the "Gross Revenues", as defined in the Bond Resolution, consisting of payments received by the Issuer from the City, designated as "Dallas Bond Payments", pursuant to a Water Transmission Facilities Financing Agreement, dated November 16, 2010 (the "Contract"), between the Issuer and the City with respect to the acquisition, construction, and financing of an integrated pipeline designated as the "Project" in the Contract. It is specifically provided in the Contract that the City is obligated to make payments in amounts sufficient to pay the principal of and interest on this Bond, when due,

and that such payments will be made solely from the gross revenues of the City's combined waterworks and sewer system.

THE ISSUER IS OBLIGATED TO PAY THE PRINCIPAL OF AND INTEREST ON THIS BOND SOLELY FROM AND TO THE EXTENT OF THE GROSS REVENUES DERIVED FROM THE DALLAS BOND PAYMENTS TO BE RECEIVED FROM THE CITY. NO OTHER ENTITY, INCLUDING THE STATE OF TEXAS, ANY POLITICAL SUBDIVISION THEREOF (OTHER THAN THE CITY), OR ANY OTHER PUBLIC OR PRIVATE BODY, IS OBLIGATED, DIRECTLY, INDIRECTLY, CONTINGENTLY, OR IN ANY OTHER MANNER, TO PAY SUCH PRINCIPAL OR INTEREST FROM ANY OTHER SOURCE WHATSOEVER. THE OWNER OF THIS BOND SHALL NEVER HAVE THE RIGHT TO DEMAND PAYMENT OF THIS BOND OUT OF ANY FUNDS RAISED OR TO BE RAISED BY TAXATION (INCLUDING SPECIFICALLY TAXES RAISED OR TO BE RAISED BY THE CITY) OR FROM ANY OTHER FUNDS OF THE ISSUER EXCEPT THE GROSS REVENUES PLEDGED TO THE PAYMENT OF THIS BOND. NO REPRESENTATION IS MADE HEREIN WITH RESPECT TO THE ANTICIPATED SUFFICIENCY OF THE GROSS REVENUES PLEDGED TO THE PAYMENT OF THIS BOND. NO PART OF THE PHYSICAL PROPERTY OF THE CITY IS ENCUMBERED BY ANY LIEN OR SECURITY INTEREST FOR THE BENEFIT OF THE OWNERS OF THIS BOND.

THE ISSUER has reserved the right, subject to the restrictions stated in the Bond Resolution, to issue Additional Bonds payable from and secured by a first lien on and pledge of the Gross Revenues on a parity with this Bond.

THE ISSUER also has reserved the right to amend the Bond Resolution, with the approval of the owners of 51% of the outstanding bonds secured by a first lien on the Gross Revenues, subject to the restrictions stated in the Bond Resolution.

THE REGISTERED OWNER hereof shall never have the right to demand payment of this Bond or the interest hereon from any source whatsoever other than specified in the Contract and the Bond Resolution.

BY BECOMING the registered owner of this Bond, the registered owner thereby acknowledges all of the terms and provisions of the Bond Resolution, agrees to be bound by such terms and provisions, acknowledges that the Bond Resolution is duly recorded and available for inspection in the official minutes and records of the governing body of the Issuer, and agrees that the terms and provisions of this Bond and the Bond Resolution constitute a contract between the registered owner hereof and the Issuer.

IN WITNESS WHEREOF, the Issuer has caused this Bond to be signed with the manual or facsimile signature of the President of the Board of Directors of the Issuer and countersigned with the manual or facsimile signature of the Secretary of the Board of Directors of the Issuer, has caused the official seal of the Issuer to be duly impressed, or placed in facsimile, on this Bond, and has caused this Bond to be dated as of _____, 2015.

Secretary, Board of Directors	President, Board of Directors

(DISTRICT SEAL)

FORM OF REGISTRATION CERTIFICATE OF THE
COMPTROLLER OF PUBLIC ACCOUNTS:

COMPTROLLER'S REGISTRATION CERTIFICATE: REGISTER NO.

I hereby certify that this Bond has been examined, certified as to validity, and approved by the Attorney General of the State of Texas, and that this Bond has been registered by the Comptroller of Public Accounts of the State of Texas.

Witness my signature and seal this

_____
Comptroller of Public Accounts of the State of Texas

(COMPTROLLER'S SEAL)

Section 6. CHARACTERISTICS OF THE SERIES 2015 BONDS. (a) Registration, Transfer, Conversion and Exchange; Authentication. The Issuer shall keep or cause to be kept at the principal corporate trust office of BOKF, NA dba Bank of Texas, Dallas, Texas (the "Paying Agent/Registrar") books or records for the registration of the transfer, conversion and exchange of the Series 2015 Bonds (the "Registration Books"), and the Issuer hereby appoints the Paying Agent/Registrar as its registrar and transfer agent to keep such books or records and make such registrations of transfers, conversions and exchanges under such reasonable regulations as the Issuer and Paying Agent/Registrar may prescribe; and the Paying Agent/Registrar shall make such registrations, transfers, conversions and exchanges as herein provided. The Paying Agent/Registrar shall obtain and record in the Registration Books the address of the registered owner of each Series 2015 Bond to which payments with respect to the Series 2015 Bonds shall be mailed, as herein provided; but it shall be the duty of each registered owner to notify the Paying Agent/Registrar in writing of the address to which payments shall be mailed, and such interest payments shall not be mailed unless such notice has been given. To the extent possible and under reasonable circumstances, all transfers of Series 2015 Bonds shall be made within three Business Days after request and presentation thereof. The Issuer shall have the right to inspect the Registration Books during regular business hours of the Paying Agent/Registrar, but otherwise the Paying Agent/Registrar shall keep the Registration Books confidential and, unless otherwise required by law, shall not permit their inspection by any other entity. The Paying Agent/Registrar's standard or customary fees and charges for making such registration, transfer, conversion, exchange and delivery of a substitute Series 2015 Bond or Series 2015 Bonds shall be paid as provided in the FORM OF BOND set forth in this Resolution. Registration of assignments, transfers, conversions and exchanges of Series 2015 Bonds shall be made in the manner provided and with the effect stated in the FORM OF BOND set forth in this Resolution. Each substitute Bond shall bear a letter and/or number to distinguish it from each other Bond.

An authorized representative of the Paying Agent/Registrar shall, before the delivery of any such Bond, date and manually sign the Paying Agent/Registrar's Authentication Certificate, and no such Bond shall be deemed to be issued or outstanding unless such Certificate is so executed. The Paying Agent/Registrar promptly shall cancel all paid Series 2015 Bonds surrendered for conversion and exchange. No additional ordinances, orders, or resolutions need be passed or adopted by the

governing body of the Issuer or any other body or person so as to accomplish the foregoing conversion and exchange of any Bond or portion thereof, and the Paying Agent/Registrar shall provide for the printing, execution, and delivery of the substitute Series 2015 Bonds in the manner prescribed herein, and said Series 2015 Bonds shall be of type composition printed on paper with lithographed or steel engraved borders of customary weight and strength. Pursuant to Subchapter D, Chapter 1201, Texas Government Code, the duty of conversion and exchange of Series 2015 Bonds as aforesaid is hereby imposed upon the Paying Agent/Registrar, and, upon the execution of said Certificate, the converted and exchanged Series 2015 Bond shall be valid, incontestable, and enforceable in the same manner and with the same effect as the Series 2015 Bonds which initially were issued and delivered pursuant to this Resolution, approved by the Attorney General, and registered by the Comptroller of Public Accounts.

(b) Payment of Series 2015 Bonds and Interest. The Issuer hereby further appoints the Paying Agent/Registrar to act as the paying agent for paying the principal of and interest on the Series 2015 Bonds, all as provided in this Resolution. The Paying Agent/Registrar shall keep proper records of all payments made by the Issuer and the Paying Agent/Registrar with respect to the Series 2015 Bonds.

(c) In General. The Series 2015 Bonds (i) shall be issued in fully registered form, without interest coupons, with the principal of and interest on such Series 2015 Bonds to be payable only to the registered owners thereof, (ii) may be redeemed prior to their scheduled maturities, (iii) may be transferred and assigned, (iv) may be converted and exchanged for other Series 2015 Bonds, (v) shall have the characteristics, (vi) shall be signed, sealed, executed and authenticated, (vii) shall be payable as to principal and interest, and (viii) shall be administered and the Paying Agent/Registrar and the Issuer shall have certain duties and responsibilities with respect to the Series 2015 Bonds, all as provided, and in the manner and to the effect as required or indicated, in the FORM OF Series 2015 Bond set forth in this Resolution. The Series 2015 Bonds initially issued and delivered pursuant to this Resolution are not required to be, and shall not be, authenticated by the Paying Agent/Registrar, but on each substitute Series 2015 Bond issued in conversion of and exchange for any Series 2015 Bond or Series 2015 Bonds issued under this Resolution the Paying Agent/Registrar shall execute the PAYING AGENT/REGISTRAR'S AUTHENTICATION CERTIFICATE, in the form set forth in the FORM OF SERIES 2015 SUBSTITUTE BOND.

(d) Substitute Paying Agent/Registrar. The Issuer covenants with the registered owners of the Series 2015 Bonds that at all times while the Series 2015 Bonds are outstanding the Issuer will provide a competent and legally qualified bank, trust company, financial institution, or other agency to act as and perform the services of Paying Agent/Registrar for the Series 2015 Bonds under this Resolution, and that the Paying Agent/Registrar will be one entity. The Issuer reserves the right to, and may, at its option, change the Paying Agent/Registrar upon not less than 120 days written notice to the Paying Agent/Registrar, to be effective not later than 60 days prior to the next principal or interest payment date after such notice. In the event that the entity at any time acting as Paying Agent/Registrar (or its successor by merger, acquisition, or other method) should resign or otherwise cease to act as such, the Issuer covenants that promptly it will appoint a competent and legally qualified bank, trust company, financial institution, or other agency to act as Paying Agent/Registrar under this Resolution. Upon any change in the Paying Agent/Registrar, the previous Paying Agent/Registrar promptly shall transfer and deliver the Registration Books (or a copy thereof), along with all other pertinent books and records relating to the Series 2015 Bonds, to the new Paying

Agent/Registrar designated and appointed by the Issuer. Upon any change in the Paying Agent/Registrar, the Issuer promptly will cause a written notice thereof to be sent by the new Paying Agent/Registrar to each registered owner of the Series 2015 Bonds, by United States mail, first-class postage prepaid, which notice also shall give the address of the new Paying Agent/Registrar. By accepting the position and performing as such, each Paying Agent/Registrar shall be deemed to have agreed to the provisions of this Resolution, and a certified copy of this Resolution shall be delivered to each Paying Agent/Registrar.

(e) Reporting Requirements of Paying Agent/Registrar. To the extent required by the Internal Revenue Code of 1986, as amended (the "Code") and the regulations promulgated and pertaining thereto, it shall be the duty of the Paying Agent/Registrar, on behalf of the Issuer, to report to the owners of the Series 2015 Bonds and the Internal Revenue Service (i) the amount of "reportable payments", if any, subject to backup withholding during each year and the amount of tax withheld, if any, with respect to payments of the Series 2015 Bonds and (ii) the amount of interest or amount treating as interest on the Series 2015 Bonds and required to be included in gross income of the owner thereof.

(f) Book-Entry Only System. The Series 2015 Bonds issued in exchange for the Series 2015 Bonds initially issued to the purchaser specified herein shall be initially issued in the form of a separate single fully registered Series 2015 Bond for each of the maturities thereof. Upon initial issuance, the ownership of each such Series 2015 Bond shall be registered in the name of Cede & Co., as nominee of Depository Trust Company of New York ("DTC"), and except as provided in subsection (f) hereof, all of the outstanding Series 2015 Bonds shall be registered in the name of Cede & Co., as nominee of DTC.

With respect to Series 2015 Bonds registered in the name of Cede & Co., as nominee of DTC, the Issuer and the Paying Agent/Registrar shall have no responsibility or obligation to any DTC Participant or to any person on behalf of whom such a DTC Participant holds an interest on the Series 2015 Bonds. Without limiting the immediately preceding sentence, the Issuer and the Paying Agent/Registrar shall have no responsibility or obligation with respect to (i) the accuracy of the records of DTC, Cede & Co. or any DTC Participant with respect to any ownership interest in the Series 2015 Bonds, (ii) the delivery to any DTC Participant or any other person, other than a Bondholder, as shown on the Registration Books, of any notice with respect to the Series 2015 Bonds, including any notice of redemption, or (iii) the payment to any DTC Participant or any other person, other than a Bondholder, as shown in the Registration Books of any amount with respect to principal of, premium, if any, or interest on, as the case may be, the Series 2015 Bonds. Notwithstanding any other provision of this Resolution to the contrary, the Issuer and the Paying Agent/Registrar shall be entitled to treat and consider the person in whose name each Series 2015 Bond is registered in the Registration Books as the absolute owner of such Series 2015 Bond for the purpose of payment of principal, premium, if any, and interest, as the case may be, with respect to such Bond, for the purpose of giving notices of redemption and other matters with respect to such Bond, for the purpose of registering transfers with respect to such Bond, and for all other purposes whatsoever. The Paying Agent/Registrar shall pay all principal of, premium, if any, and interest on the Series 2015 Bonds only to or upon the order of the respective owners, as shown in the Registration Books as provided in this Resolution, or their respective attorneys duly authorized in writing, and all such payments shall be valid and effective to fully satisfy and discharge the Issuer's obligations with respect to payment of principal of, premium, if any, and interest on, or as the case

may be, the Series 2015 Bonds to the extent of the sum or sums so paid. No person other than an owner, as shown in the Registration Books, shall receive a Series 2015 Bond certificate evidencing the obligation of the Issuer to make payments of principal, premium, if any, and interest, as the case may be, pursuant to this Resolution. Upon delivery by DTC to the Paying Agent/Registrar of written notice to the effect that DTC has determined to substitute a new nominee in place of Cede & Co., and subject to the provisions in this Resolution with respect to interest checks being mailed to the registered owner at the close of business on the Record Date, the word "Cede & Co." in this Resolution shall refer to such new nominee of DTC. The Issuer has executed and delivered to DTC a "Blanket Letter of Representation" to effect the use of a book-entry-only system for obligations such as the Series 2015 Bonds.

(g) Successor Securities Depository; Transfers Outside Book-Entry Only System. In the event that the Issuer or the Paying Agent/Registrar determines that DTC is incapable of discharging its responsibilities described herein and in the Blanket Letter of Representation of the Issuer to DTC and that it is in the best interest of the beneficial owners of the Series 2015 Bonds that they be able to obtain certificated Series 2015 Bonds, the Issuer or the Paying Agent/Registrar shall (i) appoint a successor securities depository, qualified to act as such under Section 17(a) of the Securities and Exchange Act of 1934, as amended, notify DTC and DTC Participants of the appointment of such successor securities depository and transfer one or more separate Series 2015 Bonds to such successor securities depository or (ii) notify DTC and DTC Participants of the availability through DTC of Series 2015 Bonds and transfer one or more separate Series 2015 Bonds to DTC Participants having Series 2015 Bonds credited to their DTC accounts. In such event, the Series 2015 Bonds shall no longer be restricted to being registered in the Registration Books in the name of Cede & Co., as nominee of DTC, but may be registered in the name of the successor securities depository, or its nominee, or in whatever name or names Bondholders transferring or exchanging Series 2015 Bonds shall designate, in accordance with the provisions of this Resolution.

(h) Payments to Cede & Co. Notwithstanding any other provision of this Resolution to the contrary, so long as any Bond is registered in the name of Cede & Co., as nominee of DTC, all payments with respect to principal of, premium, if any, and interest on, or as the case may be, such Bond and all notices with respect to such Bond shall be made and given, respectively, in the manner provided in the representation letter of the Issuer to DTC.

Section 7. FORM OF SERIES 2015 SUBSTITUTE BONDS. The form of all Series 2015 Bonds issued in conversion and exchange or replacement of any other Series 2015 Bond or portion thereof, including the form of Paying Agent/Registrar's Certificate to be printed on each of such Series 2015 Bonds, and the Form of Assignment to be printed on each of the Series 2015 Bonds, shall be, respectively, substantially as follows with such appropriate variations, omissions, or insertions as are permitted or required by this Resolution.

FORM OF SERIES 2015 SUBSTITUTE BOND

NO.____ PRINCIPAL AMOUNT
$_____

UNITED STATES OF AMERICA
STATE OF TEXAS
TARRANT REGIONAL WATER DISTRICT,
A WATER CONTROL AND IMPROVEMENT DISTRICT,
WATER TRANSMISSION FACILITIES CONTRACT REVENUE BOND
(CITY OF DALLAS, TEXAS PROJECT),
SERIES 2015

INTEREST RATE	MATURITY DATE	ISSUE DATE	CUSIP NO.
%	September 1, ____	_____, 2015	

ON THE MATURITY DATE specified above TARRANT REGIONAL WATER DISTRICT, A WATER CONTROL AND IMPROVEMENT DISTRICT (the "Issuer"), being a political subdivision of the State of Texas, hereby promises to pay to CEDE & CO. or to the registered assignee hereof (either being hereinafter called the "registered owner") the principal amount of _____ DOLLARS and to pay interest thereon, calculated on the basis of a 360-day year composed of twelve 30-day months, from the Issue Date specified above, to the Maturity Date specified above, or the date of redemption prior to maturity, at the interest rate per annum specified above; with interest being payable semiannually on each March 1 and September 1, commencing _____, except that if the date of authentication of this Bond is later than the first Record Date (hereinafter defined), such principal amount shall bear interest from the interest payment date next preceding the date of authentication, unless such date of authentication is after any Record Date (hereinafter defined) but on or before the next following interest payment date, in which case such principal amount shall bear interest from such next following interest payment date.

THE PRINCIPAL OF AND INTEREST ON this Bond are payable in lawful money of the United States of America, without exchange or collection charges. The principal of this Bond shall be paid to the registered owner hereof upon presentation and surrender of this Bond at maturity or upon the date fixed for its redemption prior to maturity, at the principal corporate trust office of BOKF, NA dba BANK OF TEXAS, Dallas, Texas, which is the "Paying Agent/Registrar" for this Bond. The payment of interest on this Bond shall be made by the Paying Agent/Registrar to the registered owner hereof on each interest payment date by check dated as of such interest payment date, drawn by the Paying Agent/Registrar on, and payable solely from, funds of the Issuer required by the resolution authorizing the issuance of the Bonds (the "Bond Resolution") to be on deposit with the Paying Agent/Registrar for such purpose as hereinafter provided; and such check shall be sent by the Paying Agent/Registrar by United States mail, first-class postage prepaid, on each such interest payment date, to the registered owner hereof, at the address of the registered owner, as it appeared at the close of business on the 15th day of the month next preceding each such date (the "Record Date") on the Registration Books kept by the Paying Agent/Registrar, as hereinafter

described; provided, however, for Bonds, the registered owner of which is the Texas Water Development Board (the "TWDB"), at the option of the TWDB and at the expense of the Issuer, such payment shall be made by wire transfer pursuant to written directions of the TWDB. However, notwithstanding the foregoing provisions, (1) the payment of such interest may be made by any other method acceptable to the Paying Agent/Registrar and requested by, and at the risk and expense of, the registered owner hereof and (2) upon the written request, and at the risk and expense of, the registered owner of any Bond of this Series in the amount of $1,000,000 or more, delivered to the Paying Agent/Registrar not less than 15 days prior to any interest payment date, payment of the interest due on such Bond on such date shall be paid on such date by wire transfer to any designated account in the United States of America which has available to it the wire service facilities of the Federal Reserve Bank. Any accrued interest due upon the redemption of this Bond prior to maturity as provided herein shall be paid to the registered owner at the principal corporate trust office of the Paying Agent/Registrar upon presentation and surrender of this Bond for redemption and payment at the principal corporate trust office of the Paying Agent/Registrar. The Issuer covenants with the registered owner of this Bond that on or before each principal payment date, interest payment date, and accrued interest payment date for this Bond it will make available to the Paying Agent/Registrar, from the "Interest and Redemption Fund" created by the Bond Resolution, the amounts required to provide for the payment, in immediately available funds, of all principal of and interest on the Bonds, when due.

IF THE DATE for the payment of the principal of or interest on this Bond shall be a Saturday, Sunday, a legal holiday, or a day on which banking institutions in the city where the Paying Agent/Registrar is located are authorized by law or executive order to close, then the date for such payment shall be the next succeeding day which is not such a Saturday, Sunday, legal holiday, or day on which banking institutions are authorized to close; and payment on such date shall have the same force and effect as if made on the original date payment was due.

THIS BOND is one of a series of bonds (the "Bonds") dated as of _____, 2015, authorized in accordance with the Constitution and laws of the State of Texas in the principal amount of $_____ for the purpose of obtaining funds to (i) pay for design, acquisition, and constructions costs related to the Dallas Project Component of the Project, as such terms are defined in the Bond Resolution, consisting generally of a portion of the share of the City of Dallas, Texas (the "City") of the costs of an integrated pipeline to serve the City and the Issuer, (ii) fund a reserve fund for the Bonds, and (iii) pay costs of issuance of the Bonds.

ON _____, ____, or any date thereafter, the Bonds may be redeemed prior to their scheduled maturities, at the option of the Issuer, with funds derived from any available source, as a whole, or in part, and, if in part, the Issuer shall select and designate the particular maturities and amounts of Bonds to be redeemed, and if less than all of the Bonds of a maturity are to be redeemed, the Issuer shall direct the Paying Agent/Registrar to call by lot or other customary method of random selection the particular Bonds or portions thereof to be redeemed (only in an integral multiple of $5,000), at the redemption price of the principal amount to be redeemed, plus accrued interest to the date fixed for redemption.

DURING ANY PERIOD in which ownership of the Bonds is determined by a book entry at a securities depository for the Bonds, if fewer than all of the Bonds of the same maturity and bearing the same interest rate are to be redeemed, the particular Bonds of such maturity and bearing such interest rate shall be selected in accordance with the arrangements between the Issuer and the securities depository.

AT LEAST 30 days prior to the date fixed for any redemption of Bonds or portions thereof prior to maturity at the option of the Issuer, a written notice of such redemption shall be sent by the Paying Agent/Registrar by United States mail, first-class postage prepaid, to the registered owner appearing on the Registration Books at the close of business on the day next preceding the date of mailing of such notice; provided, however, that any notice so mailed shall be conclusively presumed to have been duly given and the failure to receive such notice, or any defect therein shall not affect the validity or effectiveness of the proceedings for the redemption of any Bond at the option of the Issuer. By the date fixed for any such redemption due provision shall be made with the Paying Agent/Registrar for the payment of the required redemption price for the Bonds or portions thereof which are to be so redeemed, plus accrued interest thereon to the date fixed for redemption. If such written notice of redemption is mailed and if due provision for such payment is made, all as provided above, the Bonds or portions thereof which are to be so redeemed thereby automatically shall be treated as redeemed prior to their scheduled maturities, and they shall not bear interest after the date fixed for redemption, and they shall not be regarded as being outstanding except for the right of the registered owner to receive the redemption price plus accrued interest from the Paying Agent/Registrar out of the funds provided for such payment. If a portion of any Bond shall be redeemed a substitute Bond or Bonds having the same maturity date, bearing interest at the same rate, in any denomination or denominations in any integral multiple of $5,000, at the written request of the registered owner, and in aggregate principal amount equal to the unredeemed portion thereof, will be issued to the registered owner upon the surrender thereof for cancellation, at the expense of the Issuer, all as provided in the Bond Resolution.

THIS BOND OR ANY PORTION OR PORTIONS HEREOF IN ANY INTEGRAL MULTIPLE OF $5,000 may be assigned and shall be transferred only in the Registration Books of the Issuer kept by the Paying Agent/Registrar acting in the capacity of registrar for the Bonds, upon the terms and conditions set forth in the Bond Resolution. Among other requirements for such assignment and transfer, this Bond must be presented and surrendered to the Paying Agent/Registrar, together with proper instruments of assignment, in form and with guarantee of signatures satisfactory to the Paying Agent/Registrar, evidencing assignment of this Bond or any portion or portions hereof in any integral multiple of $5,000 to the assignee or assignees in whose name or names this Bond or any such portion or portions hereof is or are to be transferred and registered. The form of Assignment printed or endorsed on this Bond shall be executed by the registered owner or its duly authorized attorney or representative, to evidence the assignment hereof. A new Bond or Bonds payable to such assignee or assignees (which then will be the new registered owner or owners of such new Bond or Bonds), or to the previous registered owner in the case of the assignment and transfer of only a portion of this Bond, may be delivered by the Paying Agent/Registrar in conversion of and exchange for this Bond, all in the form and manner as provided in the next paragraph hereof for the conversion and exchange of other bonds. The Issuer shall pay the Paying Agent/Registrar's standard or customary fees and charges for making such transfer, but the one requesting such transfer shall pay any taxes or other governmental charges required to be paid with respect thereto. The Paying Agent/Registrar shall not be required to make transfers of registration

of this Bond or any portion hereof (i) during the period commencing with the close of business on any Record Date and ending with the opening of business on the next following principal or interest payment date, or, (ii) with respect to any Bond or any portion thereof called for redemption prior to maturity, within 45 days prior to its redemption date. The registered owner of this Bond shall be deemed and treated by the Issuer and the Paying Agent/Registrar as the absolute owner hereof for all purposes, including payment and discharge of liability upon this Bond to the extent of such payment, and the Issuer and the Paying Agent/Registrar shall not be affected by any notice to the contrary.

ALL BONDS OF THIS SERIES are issuable solely as fully registered bonds, without interest coupons, in the denomination of any integral multiple of $5,000. As provided in the Bond Resolution, this Bond, or any unredeemed portion hereof, may, at the request of the registered owner or the assignee or assignees hereof, be converted into and exchanged for a like aggregate principal amount of fully registered bonds, without interest coupons, payable to the appropriate registered owner, assignee, or assignees, as the case may be, having the same maturity date, and bearing interest at the same rate, in any denomination or denominations in any integral multiple of $5,000 as requested in writing by the appropriate registered owner, assignee, or assignees, as the case may be, upon surrender of this Bond to the Paying Agent/Registrar for cancellation, all in accordance with the form and procedures set forth in the Bond Resolution. The Issuer shall pay the Paying Agent/Registrar's standard or customary fees and charges for transferring, converting, and exchanging any Bond or any portion thereof, but the one requesting such transfer, conversion, and exchange shall pay any taxes or governmental charges required to be paid with respect thereto as a condition precedent to the exercise of such privilege of conversion and exchange. The Paying Agent/Registrar shall not be required to make any such conversion and exchange (i) during the period commencing with the close of business on any Record Date and ending with the opening of business on the next following principal or interest payment date, or, (ii) with respect to any Bond or portion thereof called for redemption prior to maturity, within 45 days prior to its redemption date.

IN THE EVENT any Paying Agent/Registrar for this Bond is changed by the Issuer, resigns, or otherwise ceases to act as such, the Issuer has covenanted in the Bond Resolution that it promptly will appoint a competent and legally qualified substitute therefor, and promptly will cause written notice thereof to be mailed to the registered owners of this Bond.

IT IS HEREBY certified, recited, and covenanted that this Bond has been duly and validly authorized, issued, and delivered; that all acts, conditions, and things required or proper to be performed, exist, and be done precedent to or in the authorization, issuance, and delivery of this Bond have been performed, existed, and been done in accordance with law; that this Bond and the interest thereon are special obligations of the Issuer, which, together with other outstanding parity revenue bonds of the Issuer, are payable from and secured by a first lien on and pledge of the "Gross Revenues", as defined in the Bond Resolution, consisting of payments received by the Issuer from the City designated as "Dallas Bond Payments", pursuant to a Water Transmission Facilities Financing Agreement, dated November 16, 2010 (the "Contract"), between the Issuer and the City with respect to the acquisition, construction, and financing of an integrated pipeline designated as the "Project" in the Contract. It is specifically provided in the Contract that the City is obligated to make payments in amounts sufficient to pay the principal of and interest on this Bond, when due, and that such payments will be made solely from the gross revenues of the City's combined waterworks and sewer system.

THE ISSUER IS OBLIGATED TO PAY THE PRINCIPAL OF AND INTEREST ON THIS BOND SOLELY FROM AND TO THE EXTENT OF THE GROSS REVENUES DERIVED FROM THE DALLAS BOND PAYMENTS TO BE RECEIVED FROM THE CITY. NO OTHER ENTITY, INCLUDING THE STATE OF TEXAS, ANY POLITICAL SUBDIVISION THEREOF (OTHER THAN THE CITY), OR ANY OTHER PUBLIC OR PRIVATE BODY, IS OBLIGATED, DIRECTLY, INDIRECTLY, CONTINGENTLY, OR IN ANY OTHER MANNER, TO PAY SUCH PRINCIPAL OR INTEREST FROM ANY OTHER SOURCE WHATSOEVER. THE OWNER OF THIS BOND SHALL NEVER HAVE THE RIGHT TO DEMAND PAYMENT OF THIS BOND OUT OF ANY FUNDS RAISED OR TO BE RAISED BY TAXATION (INCLUDING SPECIFICALLY TAXES RAISED OR TO BE RAISED BY THE CITY) OR FROM ANY OTHER FUNDS OF THE ISSUER EXCEPT THE GROSS REVENUES PLEDGED TO THE PAYMENT OF THIS BOND. NO REPRESENTATION IS MADE HEREIN WITH RESPECT TO THE ANTICIPATED SUFFICIENCY OF THE GROSS REVENUES PLEDGED TO THE PAYMENT OF THIS BOND. NO PART OF THE PHYSICAL PROPERTY OF THE CITY IS ENCUMBERED BY ANY LIEN OR SECURITY INTEREST FOR THE BENEFIT OF THE OWNERS OF THIS BOND.

THE ISSUER has reserved the right, subject to the restrictions stated in the Bond Resolution, to issue Additional Bonds payable from and secured by a first lien on and pledge of the Gross Revenues on a parity with this Bond.

THE ISSUER also has reserved the right to amend the Bond Resolution, with the approval of the owners of 51% of the outstanding bonds secured by a first lien on the Gross Revenues, subject to the restrictions stated in the Bond Resolution.

THE REGISTERED OWNER hereof shall never have the right to demand payment of this Bond or the interest hereon from any source whatsoever other than specified in the Contract and the Bond Resolution.

BY BECOMING the registered owner of this Bond, the registered owner thereby acknowledges all of the terms and provisions of the Bond Resolution, agrees to be bound by such terms and provisions, acknowledges that the Bond Resolution is duly recorded and available for inspection in the official minutes and records of the governing body of the Issuer, and agrees that the terms and provisions of this Bond and the Bond Resolution constitute a contract between each registered owner hereof and the Issuer.

IN WITNESS WHEREOF, the Issuer has caused this Bond to be signed with the facsimile signature of the President of the Board of Directors of the Issuer and countersigned with the facsimile signature of the Secretary of the Board of Directors of the Issuer, and has caused the official seal of the Issuer to be duly impressed, or placed in facsimile, on this Bond.

xxxxx	xxxxx
Secretary, Board of Directors	President, Board of Directors

(DISTRICT SEAL)

FORM OF PAYING AGENT/REGISTRAR'S AUTHENTICATION CERTIFICATE

PAYING AGENT/REGISTRAR'S AUTHENTICATION CERTIFICATE

(To be executed if this Bond is not accompanied by an executed Registration Certificate of the Comptroller of Public Accounts of the State of Texas)

It is hereby certified that this Bond has been issued under the provisions of the Bond Resolution described in the text of this Bond; and that this Bond has been issued in conversion or replacement of, or in exchange for, a bond, bonds, or a portion of a bond or bonds of a series which originally was approved by the Attorney General of the State of Texas and registered by the Comptroller of Public Accounts of the State of Texas.

Dated

BOKF, NA dba BANK OF TEXAS,
Dallas, Texas

By _____
Authorized Representative

FORM OF ASSIGNMENT:

ASSIGNMENT

FOR VALUE RECEIVED, the undersigned sells, assigns and transfers unto

Please Insert Social Security or
Other Identifying Number of Assignee

/_____/

_____

(Name and Address of Assignee)

the within Bond and does hereby irrevocably constitute and appoint _____ to transfer said Bond on the books kept for registration thereof with full power of substitution in the premises.

Date: _____

_____

Signature Guaranteed: _____

NOTICE: The signature to this assignment must correspond with the name as it appears upon the face of the within Bond in every particular, without alteration or enlargement or any change whatever; and

NOTICE: Signature(s) must be guaranteed by an eligible guarantor institution participating in a Securities Transfer Association recognized signature guarantee program.

Section 8. ADDITIONAL DEFINITIONS. In addition to the definitions heretofore provided for, the following terms as used in this Resolution shall have the meanings set forth below, unless the text hereof specifically indicates otherwise:

The term "Additional Bonds" shall mean the additional parity revenue bonds permitted to be authorized in the future on a parity with the Bonds, as hereinafter provided in Section 19 hereof.

The term "Board" shall mean the Board of Directors of the District, being the governing body of the District, and it is further resolved that the declarations and covenants of the District contained in this Resolution are made by, and for and on behalf of the Board and the District, and are binding upon the Board and the District for all purposes.

The terms "Bond Resolution" and "Resolution" shall mean this resolution authorizing the Series 2015 Bonds.

The term "Bonds" shall mean (i) the unpaid and unrefunded Series 2012 Bonds and Series 2014 Bonds to be outstanding after the delivery of the Series 2015 Bonds, (ii) the Series 2015 Bonds, and (ii) any Additional Bonds.

The term "Business Day" shall mean a day other than a Saturday, a Sunday, a legal holiday, or a day on which banking institutions are authorized by law or executive order to close in the City or the city where the principal corporate trust office of the Paying Agent/Registrar is located.

The term "City" shall mean the City of Dallas, Texas.

The term "Contract" shall mean the "Water Transmission Facilities Financing Agreement," dated November 16, 2010, between the Issuer and the City.

The term "Credit Facility" shall mean (i) a policy of insurance or a surety bond, issued by an issuer of policies of insurance insuring the timely payment of debt service on governmental obligations, provided that a nationally recognized rating agency having an outstanding rating on outstanding Bonds would rate the Bonds fully insured by a standard policy issued by the issuer on the date the policy of insurance or surety bond is issued in its two highest generic rating categories for such obligations; and (ii) a letter or line of credit issued by any financial institution, provided that a rating agency having an outstanding rating on the Bonds would rate the Bonds in its two highest generic rating categories for such Bonds on the date such letter of line of credit is issued if the letter or line of credit proposed to be issued by such financial institution secured the timely payment of the entire principal amount of the Bonds and the interest thereon.

The term "Dallas Bond Payments" shall mean the payments received by the Issuer from the City pursuant to Contract and designated in the Contract as "Dallas Bond Payments."

The term "Dallas Project Component" shall have the same meaning given such term in the Contract.

The term "Gross Revenues" shall mean the Dallas Bond Payments received by the Issuer from the City pursuant to the Contract, together with any interest earnings thereon.

The terms "Issuer" and "District" shall mean Tarrant Regional Water District, a Water Control and Improvement District.

The term "Project" shall mean the integrated pipeline designated as the "Project" in the Contract.

The term "Series 2012 Bond Resolution" shall mean the resolution authorizing the issuance of the Series 2012 Bonds.

The term "Series 2012 Bonds" shall mean all unpaid and unrefunded "Tarrant Regional Water District, a Water Control and Improvement District, Water Transmission Facilities Contract Revenue Bonds (City of Dallas Project), Series 2012.

The term "Series 2014 Bond Resolution" shall mean the resolution authorizing the issuance of the Series 2014 Bonds.

The term "Series 2014 Bonds" shall mean all unpaid and unrefunded "Tarrant Regional Water District, a Water Control and Improvement District, Water Transmission Facilities Contract Revenue Bonds (City of Dallas Project), Series 2014.

The term "Series 2015 Bonds" shall mean collectively the Initial Bond as described and defined in Sections 1, 2, and 3 of this Bond Resolution, and all substitute bonds exchanged therefor, as well as all other substitute bonds and replacement bonds issued pursuant to this Resolution, all as provided for herein.

The term "TWDB" shall mean the Texas Water Development Board.

The terms "year" and "fiscal year" shall mean the District's fiscal year, which initially shall be the twelve month period ending on September 30, but which subsequently may be any other 12 month period hereafter established by the District as a fiscal year for the purposes of the Contract and any resolution authorizing the Bonds.

Section 9. PLEDGE. (a) The Series 2015 Bonds and the interest thereon, are and shall be secured equally and ratably, on a parity, by and payable from a first lien on and pledge of the Gross Revenues; and the Series 2015 Bonds are Additional Bonds payable from and secured by, on a parity with all outstanding Bonds, a first lien on and pledge of the Gross Revenues, as permitted by Section 19 of the Series 2012 Bond Resolution and the Series 2014 Bond Resolution.

(b) It is specifically recognized that the City is required to make Dallas Bond Payments from the gross revenues of its combined waterworks and sewer system, to the Issuer pursuant to the Contract sufficient to enable the Issuer to make all deposits and payments provided for herein, and that the Bonds, and the interest thereon, are and shall be payable from and secured by a first lien on and pledge of all of the Gross Revenues, and said Gross Revenues are further pledged irrevocably to the establishment and maintenance of the Funds hereinafter created.

(c) Chapter 1208, Government Code, applies to the issuance of the Bonds and the pledge of the Gross Revenues granted by the Issuer under this Section, and is therefore valid, effective, and perfected. Should Texas law be amended at any time while the Bonds are outstanding and unpaid, the result of such amendment being that the pledge of the revenues granted by the Issuer under this Section is to be subject to the filing requirements of Chapter 9, Business & Commerce Code, in order to preserve to the registered owners of the Bonds a security interest in said pledge, the Issuer agrees to take such measures as it determines are reasonable and necessary under Texas law to comply with the applicable provisions of Chapter 9, Business & Commerce Code and enable a filing of a security interest in said pledge to occur.

Section 10. SPECIAL FUNDS. All Gross Revenues shall be accounted for separate and apart from all other funds of the Issuer, and the following special Funds created and established by the Series 2012 Bond Resolution are hereby confirmed and shall be and maintained on the books of the Issuer, so long as any of the Bonds, or interest thereon, are outstanding and unpaid:

(a) the Revenue Fund;

(b) the Interest and Redemption Fund; and

(c) the Reserve Fund.

Section 11. REVENUE FUND. All Gross Revenues shall be credited as received by the Issuer to the Revenue Fund, and shall be deposited from the Revenue Fund into the Interest and Redemption Fund and the Reserve Fund in the manner and amounts hereinafter provided.

Section 12. INTEREST AND REDEMPTION FUND. (a) There shall be deposited into the Interest and Redemption Fund the following:

(i) immediately after the delivery of the Bonds all accrued interest, if any, from the proceeds from the sale of the Bonds;

(ii) on or before each interest payment date on the Bonds, an amount sufficient, together with other amounts, if any, on hand therein, to pay the interest coming due on the Bonds on each such interest payment date;

(iii) on or before each principal payment date on the Bonds, an amount sufficient, together with other amounts, if any, on hand therein, to pay the principal coming due on the Bonds on each such principal payment date; and

(iv) on or before each redemption date for the Bonds, an amount sufficient, together with other amounts, if any, on hand therein, to pay the redemption price, including interest accrued, on Bonds called for redemption on such redemption date.

(b) The Interest and Redemption Fund shall be used solely to pay the principal of and interest on the Bonds when due, whether upon scheduled payment dates or upon earlier redemption.

Section 13. RESERVE FUND. Subject to the provisions of Section 28 of this Resolution, the Issuer shall maintain in the Reserve Fund an amount not less in market value than the average annual principal and interest requirements on all Bonds outstanding (the "Required Reserve") as of the date of any computation thereof. Immediately after the delivery of the Initial Bond, the Issuer shall cause to be deposited from the proceeds from the sale and delivery of the Initial Bond into the Reserve Fund an amount, if any, sufficient to cause the Reserve Fund to have on deposit an amount equal to the Required Reserve.

The Reserve Fund shall be used to pay the principal of or interest on the Bonds, at any time when there is not sufficient money available in the Interest and Redemption Fund for such purpose, or to pay the principal of or interest on the last maturing Bonds.

For the purpose of determining the amount on deposit to the credit of the Reserve Fund investments in which money in such account shall have been invested shall be computed at the market value of such investment. The amount on deposit to the credit of the Reserve Fund shall be computed by the Issuer at least annually, and shall be computed immediately upon any withdrawal from the Reserve Fund. The Issuer may at any time substitute a Credit Facility for all or part of the cash or other Credit Facility on deposit in, or held for the benefit of, the Reserve Fund. The amount of a Credit Facility shall be the remaining amount or remaining coverage amount thereof.

When and so long as the money and investments and/or coverage afforded by a Credit Facility in the Reserve Fund total not less than the Required Reserve, no deposits need be made to the credit of the Reserve Fund; but when and if the Reserve Fund at any time contains less than the Required Reserve, the Issuer covenants and agrees to require the City to cure the deficiency in the Required Reserve pursuant to the Contract within twelve (12) months from the date the deficiency in funds occurred. So long as the Reserve Fund contains the Required Reserve in market value, all amounts in excess of Required Reserve, if any, shall, at least annually, on or before the 25th day of August of each year, be deposited to the credit of the Interest and Redemption Fund.

Section 14. PROJECT CONSTRUCTION FUND. There shall be established a Project Construction Fund with the Issuer's depository bank and upon the delivery of each series of Bonds (other than Bonds issued for refunding purposes), the net proceeds of such Bonds, after making any required deposits to the Interest and Redemption Fund and the Reserve Fund for such Bonds, shall be deposited into the Project Construction Fund. Money in the Project Construction Fund shall be subject to disbursements by the Issuer for payment of all costs incurred in carrying out the purposes for which the Bonds are issued.

Section 15. INVESTMENTS. Money in any Fund maintained pursuant to this Resolution or any resolution authorizing Additional Bonds may, at the option of the Issuer, be invested in any or all of the authorized investments described in the Public Funds Investment Act, Chapter 2256, Texas Government Code (or any successor statute), in which the Issuer may purchase, sell and invest its funds and funds under its control. Such deposits and investments shall be made consistent with the estimated requirements of such Funds, and any obligation in which money is so invested shall be kept and held at the bank at which the Fund is maintained for the benefit of the owners of the Bonds, and shall be promptly sold and the proceeds of sale applied to the making of all payments required to be made from the Fund from which the investment was made. All earnings from the deposit or investment of any such Fund shall be credited to such Fund. All investment earnings on

deposit in the Interest and Redemption Fund shall reduce the amounts which otherwise would be required to be deposited therein, with the result that the City's principal and/or interest payments under the Contract shall be reduced accordingly.

Section 16. DEFICIENCIES OR SURPLUSES IN FUNDS. (a) If the Issuer should fail at any time to deposit into the Interest and Redemption Fund and the Reserve Fund created by this Resolution or any resolution authorizing Additional Bonds the full amounts required, amounts equivalent to such deficiencies shall be set apart and paid into said Funds from the first available Gross Revenues, and such payments shall be in addition to the amounts otherwise required to be deposited into said Funds.

(b) Subject to making the required deposits to the Interest and Redemption Fund and the Reserve Fund when and as required by this Resolution, excess Gross Revenues may be used by the Issuer for any lawful purpose related to the Dallas Project Component of the Project.

Section 17. ISSUER'S EXPENSES. The Gross Revenues in excess of those necessary to establish and maintain the Funds as required in this Resolution, or as hereafter may be required in connection with the issuance of Additional Bonds, shall be used by the Issuer to pay its expenses attributable to the Bonds and the Project, including the fees and charges of the Paying Agent/Registrar, all to the extent provided in the Contract.

Section 18. SECURITY FOR FUNDS. All Funds created by this Resolution or any resolution authorizing Additional Bonds shall be secured in the manner prescribed by law, including particularly, the Public Funds Collateral Act, Chapter 2257, Texas Government Code, for the security of public funds, and such Funds shall be used only for the purposes and in the manner permitted or required by this Resolution.

Section 19. ADDITIONAL BONDS. The Issuer reserves the right to issue additional parity revenue bonds ("Additional Bonds") for the purpose of completing the acquisition, by purchase and construction, of the Project in accordance with the Contract, and/or for the purpose of refunding any of the Bonds. Such Additional Bonds shall be considered, constitute, and be defined as "Bonds", for all purposes of this Resolution and the Contract, and when issued and delivered, they shall be payable from and secured by a first lien on and pledge of the Gross Revenues, in the same manner and to the same extent as the other Bonds; and all of the Bonds shall in all respects be on a parity and of equal dignity. The Additional Bonds may be issued in one or more installments or series, provided, however, that no such installment or series shall be issued unless:

(a) a certificate is executed by the President and Secretary of the Board of Directors of the Issuer to the effect that no default exists in connection with the Contract or any of the covenants or requirements of the resolution or resolutions authorizing the issuance of all then outstanding Bonds, and that the Reserve Fund contains the amount then required to be on deposit therein.

(b) the resolution authorizing the issuance of such installment or series of Additional Bonds shall provide for the payment of the principal of and interest on such Additional Bonds and shall confirm the Reserve Fund, as additional security for all such Additional Bonds, and the Reserve Fund shall be increased to the extent required to cause the Reserve Fund to be maintained in an amount not less than the Required Reserve after the issuance of such then proposed Additional

Bonds (or any greater amount as may, at the option of the Issuer, be provided for in any resolution authorizing the issuance of any Additional Bonds), and shall make provision for funding such Reserve Fund from Gross Revenues, or, at the option of the Issuer, from proceeds of such Additional Bonds or other available sources. The Reserve Fund may be funded in whole or in part initially, or may be funded in whole or in part from Gross Revenues by approximately equal periodic payments, not less than annual, and within not more than five years from the date of such then proposed Additional Bonds.

All calculations of principal and interest requirements of any Bonds made in connection with the issuance of any then proposed Additional Bonds shall be made as of the date of such Additional Bonds, and also in making calculations for such purpose, or for any other purpose under any resolution authorizing any Bonds, the principal amounts of any Bonds which must be redeemed prior to maturity pursuant to any applicable mandatory redemption requirements hall be deemed to be maturing amounts of principal.

Section 20. ACCOUNTS AND RECORDS. The Issuer shall keep proper books of records and accounts, separate from all other records and accounts of the Issuer, in which complete and correct entries shall be made of all transactions relating to the Contract. The Issuer shall have said books audited once each Issuer fiscal year by a Certified Public Accountant.

Section 21. ACCOUNTING REPORTS. Within one hundred fifty days after the close of each Issuer fiscal year hereafter, the Issuer will furnish, without cost, to any owner of at least twenty-five percent (25%) of any outstanding Bonds who may so request, a signed or certified copy of a report by a Certified Public Accountant covering such fiscal year, showing the following information:

(a) A detailed statement of all Gross Revenues;

(b) Balance sheet as of the end of said fiscal year;

(c) Accountant's comment regarding the manner in which the Issuer has complied with the requirements of this Resolution and his recommendations, if any, for any changes or improvements.

Section 22. INSPECTION. Any owner or owners of any Bonds shall have the right at all reasonable times to inspect all records, accounts, and data of the Issuer relating to the Contract and the Funds created by this Resolution.

Section 23. SPECIAL COVENANTS. The Issuer further covenants as follows:

(a) that other than for the payment of the Bonds, the Gross Revenues have not in any manner been pledged to the payment of any debt or obligation of the Issuer.

(b) that while any of the Bonds are outstanding, the Issuer will not, with the exception of the Additional Bonds expressly permitted by this Resolution to be issued, additionally encumber the Gross Revenues, unless said encumbrance is made junior and subordinate in all respects to the

liens, pledges, covenants, and agreements of each resolution authorizing the issuance of the Bonds, but the right of the Issuer to issue obligations for any lawful purpose payable from a subordinate lien on the Gross Revenues is specifically recognized and retained.

(c) that the Issuer will carry out all of its obligations under the Contract; and when or if necessary will promptly enforce and cause the City to carry out all of its obligations under the Contract, for the benefit of the Issuer and the owners of the Bonds, by all legal and equitable means, including the use of mandamus proceedings against the City.

Section 24. BONDS ARE SPECIAL OBLIGATIONS. The Bonds shall be special obligations of the Issuer payable from the pledged Gross Revenues, and the registered owner or owners of the Bonds shall never have the right to demand payment thereof from any source other than as provided for in the Contract and this Bond Resolution. The Issuer is not authorized to, and shall not levy, collect, or use any tax of any nature to pay the principal of or interest on any of the Bonds.

Section 25. AMENDMENT OF RESOLUTION. (a) The holders or owners of Bonds aggregating at least a majority in principal amount of the aggregate principal amount of then outstanding Bonds shall have the right to approve any amendment to any resolution authorizing the issuance of Bonds, which may be deemed necessary or desirable by the Issuer, provided, however, that nothing herein contained shall permit or be construed to permit the amendment of the terms and conditions in said resolutions or in the Bonds so as to:

(1) Make any change in the maturity of the outstanding Bonds;

(2) Reduce the rate of interest borne by any of the outstanding Bonds;

(3) Reduce the amount of the principal payable on the outstanding Bonds;

(4) Modify the terms of payment of principal of or interest on the outstanding Bonds, or impose any conditions with respect to such payment;

(5) Affect the rights of the holders of less than all of the Bonds then outstanding;

(6) Change the minimum percentage of the principal amount of Bonds necessary for consent to such amendment.

(b) If at any time the Issuer shall desire to amend a resolution under this Section, the Issuer shall cause notice of the proposed amendment to be published in a financial newspaper or journal published in the City of New York, New York, or in the City of Austin, Texas, once during each calendar week for at least two successive calendar weeks. Such notice shall briefly set forth the nature of the proposed amendment and shall state that a copy thereof is on file at the principal office of each Paying Agent/Registrar of any Bonds for inspection by all owners of Bonds. Such publication is not required, however, if notice in writing is given to each owner of Bonds.

(c) Whenever at any time not less than thirty days, and within one year, from the date of the first publication of notice or other service of written notice the Issuer shall receive an instrument or instruments executed by the owners of at least a majority in aggregate principal

amount of all Bonds and then outstanding, which instrument or instruments shall refer to the proposed amendment described in said notice and which specifically consent to and approve such amendment in substantially the form of the copy thereof on file as aforesaid, the Issuer may adopt the amendatory resolution in substantially the same form.

(d) Upon the adoption of any amendatory resolution pursuant to the provisions of this Section, the resolution being amended shall be deemed to be amended in accordance with the amendatory resolution, and the respective rights, duties, and obligations of the Issuer and all the holders or owners of then outstanding Bonds and all future Bonds shall thereafter be determined, exercised, and enforced hereunder, subject in all respects to such amendment.

(e) Any consent given by the owner of a Bond pursuant to the provisions of this Section shall be irrevocable for a period of six months from the date of the first publication of the notice provided for in this Section, and shall be conclusive and binding upon all future owners of the same Bond during such period. Such consent may be revoked at any time after six months from the date of the first publication of such notice by the owner who gave such consent, or by a successor in title, by filing notice thereof with the Paying Agent/Registrar for such Bond, and the Issuer, but such revocation shall not be effective if the owners of at least a majority in aggregate principal amount of the then outstanding Bonds as in this Section defined have, prior to the attempted revocation, consented to and approved the amendment.

(f) For the purpose of this Section, the ownership of any Bond shall be ascertained by the registration books pertaining thereto kept by the Paying Agent/Registrar therefor. The Issuer may conclusively assume that such holding or ownership continues until written notice to the contrary is served upon the Issuer.

Section 26. DEFEASANCE OF BONDS. (a) The Bonds and the interest thereon shall be deemed to be paid, retired, and no longer outstanding (a "Defeased Bond") within the meaning of this Resolution, except to the extent provided in subsection (d) of this Section, when payment of the principal of such Bond, plus interest thereon to the due date (whether such due date be by reason of maturity, upon redemption, or otherwise) either (i) shall have been made or caused to be made in accordance with the terms thereof (including the giving of any required notice of redemption), or (ii) shall have been provided for on or before such due date by irrevocably depositing with or making available to the Paying Agent/Registrar for such payment (1) lawful money of the United States of America sufficient to make such payment or (2) Government Obligations which mature as to principal and interest in such amounts and at such times as will insure the availability, without reinvestment, of sufficient money to provide for such payment, and when proper arrangements have been made by the Issuer with the Paying Agent/Registrar for the payment of its services until all Defeased Bonds shall have become due and payable. At such time as a Bond shall be deemed to be a Defeased Bond hereunder, as aforesaid, such Bond and the interest thereon shall no longer be secured by, payable from, or entitled to the benefits of, the Gross Revenues as provided in this Resolution, and such principal and interest shall be payable solely from such money or Government Obligations.

(b) Any moneys so deposited with the Paying Agent/Registrar may at the written direction of the Issuer also be invested in Government Obligations, maturing in the amounts and times as hereinbefore set forth, and all income from such Government Obligations received by the

Paying Agent/Registrar which is not required for the payment of the Bonds and interest thereon, with respect to which such money has been so deposited, shall be turned over to the Issuer, or deposited as directed in writing by the Issuer.

(c) The term "Government Obligations" as used in this Section shall mean (i) direct, noncallable obligations of the United States of America, including obligations that are unconditionally guaranteed by the United States of America, (ii) noncallable obligations of an agency or instrumentality of the United States of America, including obligations that are unconditionally guaranteed or insured by the agency or instrumentality and that, on the date the Board of Directors adopts or approves proceedings authorizing the issuance of refunding bonds or otherwise provide for the funding of an escrow to effect the defeasance of the Bonds, are rated as to investment quality by a nationally recognized investment rating firm not less than "AAA" or its equivalent, and (iii) noncallable obligations of a state or an agency or a county, municipality, or other political subdivision of a state that have been refunded and that, on the date the Board of Directors adopts or approves proceedings authorizing the issuance of refunding bonds or otherwise provide for the funding of an escrow to effect the defeasance of the Bonds, are rated as to investment quality by a nationally recognized investment rating firm no less than "AAA" or its equivalent.

(d) Until all Defeased Bonds shall have become due and payable, the Paying Agent/Registrar shall perform the services of Paying Agent/Registrar for such Defeased Bonds the same as if they had not been defeased, and the Issuer shall make proper arrangements to provide and pay for such services as required by this Resolution.

Section 27. DAMAGED, MUTILATED, LOST, STOLEN, OR DESTROYED BONDS. (a) Replacement Bonds. In the event any outstanding Bond is damaged, mutilated, lost, stolen, or destroyed, the Paying Agent/Registrar shall cause to be printed, executed, and delivered, a new bond of the same principal amount, maturity, and interest rate, as the damaged, mutilated, lost, stolen, or destroyed Bond, in replacement for such Bond in the manner hereinafter provided.

(b) Application for Replacement Bonds. Application for replacement of damaged, mutilated, lost, stolen, or destroyed Bonds shall be made by the registered owner thereof to the Paying Agent/Registrar. In every case of loss, theft, or destruction of a Bond, the registered owner applying for a replacement bond shall furnish to the Issuer and to the Paying Agent/Registrar such security or indemnity as may be required by them to save each of them harmless from any loss or damage with respect thereto. Also, in every case of loss, theft, or destruction of a Bond, the registered owner shall furnish to the Issuer and to the Paying Agent/Registrar evidence to their satisfaction of the loss, theft, or destruction of such Bond, as the case may be. In every case of damage or mutilation of a Bond, the registered owner shall surrender to the Paying Agent/Registrar for cancellation the Bond so damaged or mutilated.

(c) No Default Occurred. Notwithstanding the foregoing provisions of this Section, in the event any such Bond shall have matured, and no default has occurred which is then continuing in the payment of the principal of, redemption premium, if any, or interest on the Bond, the Issuer may authorize the payment of the same (without surrender thereof except in the case of a damaged or mutilated Bond) instead of issuing a replacement Bond, provided security or indemnity is furnished as above provided in this Section.

(d) Charge for Issuing Replacement Bonds. Prior to the issuance of any replacement bond, the Paying Agent/Registrar shall charge the registered owner of such Bond with all legal, printing, and other expenses in connection therewith. Every replacement bond issued pursuant to the provisions of this Section by virtue of the fact that any Bond is lost, stolen, or destroyed shall constitute a contractual obligation of the Issuer whether or not the lost, stolen, or destroyed Bond shall be found at any time, or be enforceable by anyone, and shall be entitled to all the benefits of this Resolution equally and proportionately with any and all other Bonds duly issued under this Resolution.

(e) Authority for Issuing Replacement Bonds. In accordance with Chapter 1201, Texas Government Code, this Section of this Resolution shall constitute authority for the issuance of any such replacement bond without necessity of further action by the governing body of the Issuer or any other body or person, and the duty of the replacement of such bonds is hereby authorized and imposed upon the Paying Agent/Registrar, and the Paying Agent/Registrar shall authenticate and deliver such Bonds in the form and manner and with the effect, as provided in Section 6(d) of this Resolution for Bonds issued in conversion and exchange for other Bonds.

Section 28. COVENANTS REGARDING TAX-EXEMPTION. (a) Covenant. The Issuer covenants to refrain from any action which would adversely affect, or to take such action to assure, the treatment of the Series 2015 Bonds as obligations described in section 103 of the Code, the interest on which is not includable in the "gross income" of the holder for purposes of federal income taxation. In furtherance thereof, the Issuer covenants as follows:

(1) to take any action to assure that no more than 10 percent of the proceeds of the Series 2015 Bonds or the projects financed therewith (less amounts deposited into a reserve fund, if any) are used for any "private business use," as defined in section 141(b)(6) of the Code, or if more than 10 percent of the proceeds or the projects financed therewith are so used, such amounts, whether or not received by the Issuer, with respect to such private business use, do not, under the terms of this Resolution or any underlying arrangement, directly or indirectly, secure or provide for the payment of more than 10 percent of the debt service on the Series 2015 Bonds, in contravention of section 141(b)(2) of the Code;

(2) to take any action to assure that in the event that the "private business use" described in subsection (a) hereof exceeds five percent of the proceeds of the Series 2015 Bonds or the projects financed therewith (less amounts deposited into a reserve fund, if any) then the amount in excess of five percent is used for a "private business use" which is "related" and not "disproportionate," within the meaning of section 141(b)(3) of the Code, to the governmental use;

(3) to take any action to assure that no amount which is greater than the lesser of $5,000,000, or five percent of the proceeds of the Series 2015 Bonds (less amounts deposited into a reserve fund, if any) is, directly or indirectly, used to finance loans to persons, other than state or local governmental units, in contravention of section 141(c) of the Code;

(4) to refrain from taking any action that would otherwise result in the Series 2015 Bonds being treated as "private activity bonds" within the meaning of section 141(b) of the Code;

(5) to refrain from taking any action that would result in the Series 2015 Bonds being "federally guaranteed" within the meaning of section 149(b) of the Code;

(6) to refrain from using any portion of the proceeds of the Series 2015 Bonds, directly or indirectly, to acquire or to replace funds which were used, directly or indirectly, to acquire investment property (as defined in section 148(b)(2) of the Code) which produces a materially higher yield over the term of the Series 2015 Bonds, other than investment property acquired with --

(A) proceeds of the Series 2015 Bonds invested for a reasonable temporary period of 3 years or less or, in the case of a refunding bond, for a period of 30 days or less until such proceeds are needed for the purpose for which the Series 2015 Bonds are issued,

(B) amounts invested in a bona fide debt service fund, within the meaning of section 1.148-1(b) of the Treasury Regulations, and

(C) amounts deposited in any reasonably required reserve or replacement fund to the extent such amounts do not exceed 10 percent of the stated principal amount (or, in the case of a discount, the issue price) of the Series 2015 Bonds;

(7) to otherwise restrict the use of the proceeds of the Series 2015 Bonds or amounts treated as proceeds of the Series 2015 Bonds, as may be necessary, so that the Series 2015 Bonds do not otherwise contravene the requirements of section 148 of the Code (relating to arbitrage), section 149(g) of the Code (relating to hedge bonds), and, to the extent applicable, section 149(d) of the Code (relating to advance refundings); and

(8) to pay to the United States of America at least once during each five-year period (beginning on the date of delivery of the Series 2015 Bonds) an amount that is at least equal to 90 percent of the "Excess Earnings," within the meaning of section 148(f) of the Code and to pay to the United States of America, not later than 60 days after the Series 2015 Bonds have been paid in full, 100 percent of the amount then required to be paid as a result of Excess Earnings under section 148(f) of the Code.

(b) Rebate Fund. In order to facilitate compliance with the above covenant (a)(8), a "Rebate Fund" is hereby established by the Issuer for the sole benefit of the United States of America, and such fund shall not be subject to the claim of any other person, including without limitation, the bondholders. The Rebate Fund is established for the additional purpose of compliance with section 148 of the Code.

(c) Compliance with Code. For purposes of the foregoing (a)(1) and (a)(2), the Issuer understands that the term "proceeds" includes "disposition proceeds" as defined in the Treasury Regulations. It is the understanding of the Issuer that the covenants contained herein are intended

to assure compliance with the Code and any regulations or rulings promulgated by the U.S. Department of the Treasury pursuant thereto. In the event that regulations or rulings are hereafter promulgated which modify or expand provisions of the Code, as applicable to the Series 2015 Bonds, the Issuer will not be required to comply with any covenant contained herein to the extent that such failure to comply, in the opinion of nationally-recognized bond counsel, will not adversely affect the exemption from federal income taxation of interest on the Series 2015 Bonds under section 103 of the Code. In the event that regulations or rulings are hereafter promulgated which impose additional requirements which are applicable to the Series 2015 Bonds, the Issuer agrees to comply with the additional requirements to the extent necessary, in the opinion of nationally-recognized bond counsel, to preserve the exemption from federal income taxation of interest on the Series 2015 Bonds under section 103 of the Code. In furtherance of such intention, the Issuer hereby authorizes and directs its President or General Manager to execute any documents, certificates or reports required by the Code and to make such elections, on behalf of the Issuer, which may be permitted by the Code as are consistent with the purpose for the issuance of the Series 2015 Bonds. The Issuer covenants to comply with the covenants contained in this Section after defeasance of the Series 2015 Bonds.

(d) Written Procedures. Unless superseded by another action of the Issuer to ensure compliance with the covenants contained herein regarding private business use, remedial actions, arbitrage and rebate, the Issuer hereby adopts and establishes the instructions attached hereto as Exhibit A as their written procedures applicable to Bonds issued pursuant to the Contract.

Section 29. ALLOCATION OF, AND LIMITATION ON, EXPENDITURES FOR THE PROJECT. The Issuer covenants to account for the expenditure of sale proceeds and investment earnings to be used for the Project on its books and records by allocating proceeds to expenditures within 18 months of the later of the date that (1) the expenditure is made, or (2) the Project is completed. The foregoing notwithstanding, the Issuer shall not expend sale proceeds or investment earnings thereon more than 60 days after the later of (1) the fifth anniversary of the delivery of the Series 2015 Bonds, or (2) the date the Series 2015 Bonds are retired, unless the Issuer obtains an opinion of nationally-recognized bond counsel that such expenditure will not adversely affect the tax-exempt status of the Series 2015 Bonds. For purposes hereof, the Issuer shall not be obligated to comply with this covenant if it obtains an opinion that such failure to comply will not adversely affect the excludability for federal income tax purposes from gross income of the interest.

Section 30. DISPOSITION OF PROJECT. The Issuer covenants that the property constituting the Project will not be sold or otherwise disposed in a transaction resulting in the receipt by the Issuer of cash or other compensation, unless the Issuer obtains an opinion of nationally-recognized bond counsel that such sale or other disposition will not adversely affect the tax-exempt status of the Bonds. For purposes of the foregoing, the portion of the property comprising personal property and disposed in the ordinary course shall not be treated as a transaction resulting in the receipt of cash or other compensation. For purposes hereof, the Issuer shall not be obligated to comply with this covenant if it obtains an opinion that such failure to comply will not adversely affect the excludability for federal income tax purposes from gross income of the interest.

Section 31. CUSTODY, APPROVAL, AND REGISTRATION OF INITIAL BOND; CO-BOND COUNSEL'S OPINION, CUSIP NUMBERS, AND PREAMBLE. The President of the

Board of Directors of the Issuer is hereby authorized to have control of the Initial Bond issued hereunder and all necessary records and proceedings pertaining to the Initial Bond pending its delivery and its investigation, examination, and approval by the Attorney General of the State of Texas, and its registration by the Comptroller of Public Accounts of the State of Texas. Upon registration of the Initial Bond said Comptroller of Public Accounts (or a deputy designated in writing to act for said Comptroller) shall manually sign the Comptroller's Registration Certificate on the Initial Bond, and the seal of said Comptroller shall be impressed, or placed in facsimile, on the Initial Bond. The approving legal opinion of the Issuer's Co-Bond Counsel and the assigned CUSIP numbers may, at the option of the Issuer, be printed on the Initial Bond or on any Series 2015 Bonds issued and delivered in conversion of and exchange or replacement of any Series 2015 Bond, but neither shall have any legal effect, and shall be solely for the convenience and information of the registered owners of the Series 2015 Bonds. The preamble to this Resolution is hereby adopted and made a part hereof for all purposes.

Section 32. INTEREST EARNINGS ON SERIES 2015 BOND PROCEEDS. Interest earnings derived from the investment of proceeds from the sale of the Series 2015 Bonds shall be used along with other bond proceeds for the acquisition and construction of the Project in accordance with the Contract; provided that after completion of the Project, if any of such interest earnings remain on hand, such interest earnings shall be deposited in the Interest and Redemption Fund. It is further provided, however, that any interest earnings on bond proceeds which are required to be rebated to the United States of America pursuant to this Resolution in order to prevent the Series 2015 Bonds from being arbitrage bonds shall be so rebated and not considered as interest earnings for the purposes of this Section.

Section 33. ESCROW AGREEMENT. If required by the TWDB as a condition to the purchase of the Bonds, the President, any Vice President, the Secretary, and/or the General Manager is authorized to execute and deliver an escrow agreement in substantially the form attached as Exhibit C. In such case, proceeds of the Bonds required to be deposited under an escrow agreement shall be disposed of and released in accordance with TWDB Rules Relating to Financial Programs or as otherwise authorized and directed by the TWDB.

Section 34. SALE OF SERIES 2015 BONDS. The Series 2015 Bonds are hereby sold and shall be delivered to the TWDB at a purchase price equal to 100% of the principal amount thereof. The officers of the Issuer are authorized to do any and all things necessary in connection with the issuance of the Series 2015 Bonds, and are authorized to execute and deliver such certificates as are necessary or appropriate in connection with the issuance of the Series 2015 Bonds. It is hereby officially found, determined, and declared that the terms of this sale are the most advantageous reasonably obtainable. The Initial Bond shall be registered in the name of the TWDB or its designee.

Section 35. TWDB REQUIREMENTS. The Issuer covenants and agrees, so long as the TWDB owns all of the Series 2015 Bonds, as follows:

(a) FINAL ACCOUNTING. The Issuer shall render a final accounting to the TWDB in reference to the total costs incurred by the Issuer with proceeds of the Series 2015 Bonds.

(b) SURPLUS BOND PROCEEDS. To the extent that any proceeds of the Series 2015 Bonds remain after payment of all costs to be paid with proceeds of the Series 2015 Bonds, such surplus proceeds shall be used to purchase or redeem and cancel the Series 2015 Bonds, in inverse order of their maturity, owned by the TWDB; provided that any remaining amounts less than $5,000 shall be deposited to the Interest and Sinking Fund.

(c) ANNUAL REPORTS. Annual audits of the Issuer required by Section 20 hereof shall be delivered to the TWDB within 120 days of the close of each fiscal year.

(d) COMPLIANCE WITH THE TWDB'S RULES AND REGULATIONS. The Issuer shall comply with the rules and regulations of the TWDB, and shall maintain any insurance on the District's Water System in an amount determined by the TWDB to be sufficient to protect the TWDB's interest. Additionally, the Issuer covenants to invest the proceeds received from the sale of the Series 2015 Bonds only in accordance with the Public Funds Investment Act, Chapter 2256, Texas Government Code, as amended, and to secure such proceeds as required by the Public Securities Collateral Act, Chapter 2257, Texas Government Code, as amended.

(e) CONSTRUCTION FUND. The Issuer shall maintain on its books a Construction Fund, separate and apart from all other funds of the District, into which it shall deposit and disburse proceeds of the Series 2015 Bonds (except for any proceeds required by this Resolution to be deposited into the Interest and Redemption Fund and the Reserve Fund).

(f) ENVIRONMENTAL INDEMNIFICATION. The Issuer agrees to indemnify, hold harmless, and protect the TWDB from any and all claims, causes of action or damages to the person or property of third parties arising from the sampling, analysis, transport and/or removal and disposition of any contaminated sewage sludge, contaminated sediments and/or contaminated media that may be generated by the Issuer, its contractors, consultants, agents, officials and employees as a result of activities relating to the project financed with proceeds of the Series 2015 Bonds to the extent permitted by law.

(g) WATER CONSERVATION PLAN. The Issuer will implement and/or assist in the implementation of water conservation plans approved by the TWDB.

Section 36. ATTORNEY GENERAL FEES. The Issuer hereby authorizes and directs payment, from legally available funds of the Issuer, of the nonrefundable examination fee of the Attorney General of the State of Texas required by Section 1202.004, Texas Government Code, as amended.

Section 37. FURTHER PROCEDURES. The President and the Secretary of the Board of Directors and the General Manager and the Finance Director of the Issuer, and all other officers, employees, and agents of the Issuer, and each of them, shall be and they are hereby expressly authorized, empowered, and directed from time to time and at any time to do and perform all such acts and things and to execute, acknowledge, and deliver in the name and on behalf of the Issuer all such instruments, whether or not herein mentioned, as may be necessary or desirable in order to carry out the terms and provisions of this Resolution, and all details in connection therewith. In case any officer whose signature shall appear on any Series 2015 Bond shall cease to be such officer

before the delivery of such Series 2015 Bond, such signature shall nevertheless be valid and sufficient for all purposes the same as if such officer had remained in office until such delivery.

Section 38. CONTINUING DISCLOSURE UNDERTAKING.

(a) Annual Reports.

The Issuer shall provide or cause the City to provide annually to the MSRB, within six months after the end of each fiscal year of the City ending in or after 2015, financial information and operating data (i) of the general type included in the final Official Statement authorized by Section 34 of this Resolution, being the information described in Exhibit B hereto. Any financial information so to be provided shall be (1) prepared in accordance with the accounting principles described in Exhibit B hereto, or such other accounting principles as the City may be required to employ from time to time pursuant to state law or regulation, and (2) audited, if the City commissions an audit of such statements and the audit is completed within the period during which they must be provided. If the audit of such financial statements of the City are not complete within such period, then the Issuer shall provide or cause the City to provide unaudited financial information and operating data which is customarily prepared by the City by the required time to the MSRB, and will provide audited information when and if the audit report becomes available.

If the City changes its fiscal year, the Issuer will notify or cause the City to notify the MSRB the change (and of the date of the new fiscal year end) prior to the next date by which the Issuer or the City otherwise would be required to provide financial information and operating data pursuant to this Section.

The financial information and operating date to be provided pursuant to this Section may be set forth in full in one or more documents or may be included by specific reference to any document (including an official statement or other offering document, if it is available from the MSRB) that theretofore has been provided to the MSRB or filed with the SEC.

(b) Disclosure Event Notices.

The Issuer shall notify or cause the City to notify the MSRB, in a timely manner, of any of the following events with respect to the Series 2015 Bonds, not in excess of ten Business Days after occurrence of the event:

1. Principal and interest payment delinquencies;

2. Non-payment related defaults, if material;

3. Unscheduled draws on debt service reserves reflecting financial difficulties;

4. Unscheduled draws on credit enhancements reflecting financial difficulties;

5. Substitution of credit or liquidity providers, or their failure to perform;

6. Adverse tax opinions, the issuance by the Internal Revenue Service of

proposed or final determinations of taxability, Notices of Proposed Issue (IRS Form 5701-TEB) or other material notices or determinations with respect to the tax status of the security, or other material events affecting the tax status of the security;

7. Modifications to the rights of security holders, if material;

8. Bond calls, if material, and tender offers;

9. Defeasances;

10. Release, substitution or sale of property securing repayment of the securities, if material;

11. Rating changes;

12. Bankruptcy, insolvency, receivership or similar event of the City;

13. The consummation of a merger, consolidation, or acquisition involving the City or the sale of all or substantially all of the assets of the City, other than in the ordinary course of business, the entry into a definitive agreement to undertake such an action or the termination of a definitive agreement relating to any such actions, other than pursuant to its terms, if material; and

14. Appointment of a successor or additional trustee or the change of name of a trustee, if material.

The Issuer shall notify or cause the City to notify the MSRB, in a timely manner, of any failure by the Issuer or the City to provide financial information or operating data in accordance with Section 37(a) of this Resolution by the time required by such Section. As used in clause 12 above, the phrase "bankruptcy, insolvency, receivership or similar event" means the appointment of a receiver, fiscal agent, or similar officer for the Issuer in a proceeding under the U.S. Bankruptcy Code or in any other proceeding under state or federal law in which a court or governmental authority has assumed jurisdiction over substantially all of the assets or business of the Issuer, or if jurisdiction has been assumed by leaving the Board of Directors and official or officers of the Issuer in possession but subject to the supervision and orders of a court or governmental authority, or the entry of an order confirming a plan of reorganization, arrangement or liquidation by a court or governmental authority having supervision or jurisdiction over substantially all of the assets or business of the Issuer.

(c) Limitations, Disclaimers, and Amendments.

The Issuer shall be obligated to observe and perform or cause the City to observe and perform the covenants specified in this Section, except that the Issuer in any event will give notice of any deposit made in accordance with Section 26 hereof that causes Series 2015 Bonds no longer to be Outstanding.

The provisions of this Section are for the sole benefit of the Holders and beneficial owners of the Series 2015 Bonds, and nothing in this Section, express or implied, shall give any benefit or

any legal or equitable right, remedy, or claim hereunder to any other person. The Issuer undertakes to provide or cause the City to provide only the financial information, operating data, financial statements, and notices which it has expressly agreed to provide pursuant to this Section and does not hereby undertake to provide or cause to be provided any other information that may be relevant or material to a complete presentation of the City's financial results, condition or prospects or hereby undertake to update any information provided in accordance with this Section or otherwise, except as expressly provided herein. The Issuer does not make any representation or warranty concerning such information or its usefulness to a decision to invest in or sell Series 2015 Bonds at any future date.

UNDER NO CIRCUMSTANCES SHALL THE ISSUER BE LIABLE TO THE HOLDER OR BENEFICIAL OWNER OF ANY SERIES 2015 BOND OR ANY OTHER PERSON, IN CONTRACT OR TORT, FOR DAMAGES RESULTING IN WHOLE OR IN PART FROM ANY BREACH BY THE ISSUER, WHETHER NEGLIGENT OR WITHOUT FAULT ON ITS PART, OF ANY COVENANT SPECIFIED IN THIS SECTION, BUT VERY RIGHT AND REMEDY OF ANY SUCH PERSON, IN CONTRACT OR TORT, FOR OR ON ACCOUNT OF ANY SUCH BREACH SHALL BE LIMITED TO AN ACTION FOR MANDAMUS OR SPECIFIC PERFORMANCE.

No default by the Issuer in observing or performing its obligations under this Section shall comprise a breach of or default under this Resolution for purposes of any other provision of this Resolution.

Nothing in this Section is intended or shall act to disclaim, waive, or otherwise limit the duties of the Issuer under federal and state securities laws.

The provisions of this Section may be amended by the Issuer from time to time to adapt to changed circumstances that arise from a change in legal requirements, a change in law, or a change in the identify, nature, status, or type of operations of the City, but only if (1) the provisions of this Section, as so amended, would have permitted an underwriter to purchase or sell Series 2015 Bonds in the primary offering of the Series 2015 Bonds in compliance with the Rule, taking into account any amendments or interpretations of the Rule since such offering as well s such changed circumstances and (2) either (a) the Holders of a majority in aggregate principal amount (or any greater amount required by any other provision of this Resolution that authorizes such an amendment) of the outstanding Series 2015 Bonds consent to such amendment or (b) a Person that is unaffiliated with the Issuer (such as nationally recognized bond counsel) determined that such amendment will not materially impair the interest of the Holders and beneficial owners of the Series 2015 Bonds. If the Issuer so amends the provisions of this Section, it shall include, or cause the City to include, with any amended financial information or operating data next provided in accordance with Subsection (a) hereof an explanation, in narrative form, of the reason for the amendment and of the impact of any change in the type of financial information or operating data so provided. The Issuer may also amend or repeal the provisions of this continuing disclosure agreement if the SEC amends or repeals the applicable provision of the Rule or a court of final jurisdiction enters judgment that such provisions of the Rule are invalid, but only if and to the extent that the provisions of this sentence would not prevent an underwriter from lawfully purchasing or selling Series 2015 Bonds in the primary offering of the Series 2015 Bonds.

(d) Definitions.

As used in this Section, the following terms have the meanings ascribed to such terms below:

"*MSRB*" means the Municipal Securities Rulemaking Board.

"*Rule*" means SEC Rule 15c2-12, as amended from time to time.

"*SEC*" means the United States Securities and Exchange Commission and any successor to its duties.

Section 39. REPEAL OF CONFLICTING RESOLUTIONS. All resolutions and all parts of any resolutions which are in conflict or inconsistent with this Resolution are hereby repealed and shall be of no further force or effect to the extent of such conflict or inconsistency.

Section 40. PUBLIC NOTICE. It is hereby officially found and determined that public notice of the time, place and purpose of said meeting was given, all as required by the Government Code, Chapter 551.

EXHIBIT A

WRITTEN PROCEDURES RELATING TO CONTINUING
COMPLIANCE WITH FEDERAL TAX COVENANTS

A. Arbitrage. With respect to the investment and expenditure of the proceeds of the Bonds (the "Obligations") the Issuer's General Manager, Assistant General Manager, and Finance Director (the "Responsible Persons") will :

For Obligations issued for newly acquired property or constructed property:

- instruct the appropriate person or persons that the construction, renovation or acquisition of the facilities must proceed with due diligence and that binding contracts for the expenditure of at least 5%of the proceeds of the Obligations will be entered into within 6 months of the Issue Date;
- monitor that at least 85% of the proceeds of the Obligations to be used for the construction, renovation or acquisition of any facilities are expended within 3 years of the date of delivery of the Obligations ("Issue Date");
- restrict the yield of the investments (other than those in the Reserve Fund) to the yield on the Obligations after 3 years of the Issue Date;
- monitor all amounts deposited into a sinking fund or funds, e.g., the Interest and Redemption Fund and the Reserve Fund, to assure that the maximum amount invested at a yield higher than the yield on the Obligations does not exceed an amount equal to the debt service on the Obligations in the succeeding 12 month period plus a carryover amount equal to one-twelfth of the principal and interest payable on the Obligations for the immediately preceding 12-month period;
- assure that no more than 50% of the proceeds of the Obligations are invested in an investment with a guaranteed yield for 4 years or more;
- assure that the maximum amount of the Reserve Fund invested at a yield higher than the yield on the Obligations will not exceed the lesser of (1) 10% of the original principal amount of the Obligations, (2) 125% of the average annual debt service on the Obligations measured as of the Issue Date, or (3) 100% of the maximum annual debt service on the Obligations as of the Issue Date;

For Obligations issued for refunding purposes:

- monitor the actions of the escrow agent (to the extent an escrow is funded with proceeds) to assure compliance with the applicable provisions of the escrow agreement, including with respect to reinvestment of cash balances;

For all Obligations:

- maintain any official action of the Issuer (such as a reimbursement resolution) stating its intent to reimburse itself or the City with the proceeds of the Obligations any amount expended prior to the Issue Date for the acquisition, renovation or construction of the facilities;

- assure that the applicable information return (e.g., IRS Form 8038-G, 8038-GC, or any successor forms) is timely filed with the IRS;

- assure that, unless excepted from rebate and yield restriction under section 148(f) of the Code, excess investment earnings are computed and paid to the U.S. government at such time and in such manner as directed by the IRS (i) at least every 5 years after the Issue Date and (ii) within 30 days after the date the Obligations are retired.

B. Private Business Use. With respect to the use of the facilities financed or refinanced with the proceeds of the Obligations the Responsible Persons will:

- monitor the date on which the facilities are substantially complete and available to be used for the purpose intended;

- monitor whether, at any time the Obligations are outstanding, any person, other than the Issuer or the City, the employees of the Issuer or the City, the agents of the Issuer or the City or members of the general public has any contractual right (such as a lease, purchase, management or other service agreement) with respect to any portion of the facilities;

- monitor whether, at any time the Obligations are outstanding, any person, other than the Issuer or the City, the employees of the Issuer or the City, the agents of the Issuer or the City or members of the general public has a right to use the output of the facilities (e.g., water, gas, electricity);

- monitor whether, at any time the Obligations are outstanding, any person, other than the Issuer or the City, the employees of the Issuer or the City, the agents of the Issuer or the City or members of the general public has a right to use the facilities to conduct or to direct the conduct of research;

- determine whether, at any time the Obligations are outstanding, any person, other than the Issuer or the City, has a naming right for the facilities or any other contractual right granting an intangible benefit;

- determine whether, at any time the Obligations are outstanding, the facilities are sold or otherwise disposed of; and

- take such action as is necessary to remediate any failure to maintain compliance with the covenants contained in the resolution authorizing the Obligations.

C. Record Retention. The Responsible Persons will maintain or cause to be maintained all records relating to the investment and expenditure of the proceeds of the Obligations and the use of the facilities financed or refinanced thereby for a period ending three (3) years after the complete extinguishment of the Obligations. If any portion of the Obligations is refunded with the proceeds of another series of tax-exempt obligations, such records shall be maintained until the three (3) years after the refunding obligations are completely extinguished. Such records can be maintained in paper or electronic format.

D. Responsible Persons. Each Responsible Person shall receive appropriate training regarding the Issuer's accounting system, contract intake system, facilities management and other systems necessary to track the investment and expenditure of the proceeds and the use of the facilities financed with the proceeds of the Obligations. The foregoing notwithstanding, the Responsible Persons are authorized and instructed to retain such experienced advisors and agents as may be necessary to carry out the purposes of these instructions.

EXHIBIT B

DESCRIPTION OF ANNUAL FINANCIAL INFORMATION

The following information is referred to in Section 38 of this Resolution.

I. Annual Financial Statements and Operating Data

The financial information and operating data with respect to the Issuer to be provided annually in accordance with such Section are as specified below:

Accounting Principles

The accounting principles referred to in such Section are the accounting principles described in the notes to the financial statements referred to in paragraph 1 above.

EXHIBIT "C"

ESCROW AGREEMENT

RESOLUTION AUTHORIZING THE ISSUANCE, SALE, AND DELIVERY OF TARRANT REGIONAL WATER DISTRICT, A WATER CONTROL AND IMPROVEMENT DISTRICT, WATER REVENUE BONDS, SERIES 2015A, PLEDGING REVENUES FOR THE PAYMENT OF THE BONDS, AND AUTHORIZING OTHER INSTRUMENTS AND PROCEDURES RELATING THERETO

THE STATE OF TEXAS	§
COUNTY OF TARRANT	§
TARRANT REGIONAL WATER DISTRICT A WATER CONTROL AND IMPROVEMENT DISTRICT	§

WHEREAS, Tarrant Regional Water District, a Water Control and Improvement District, (formerly known as "Tarrant County Water Control and Improvement District Number One") (the "Issuer" or the "District") is a political subdivision of the State of Texas, being a conservation and reclamation district created and functioning under Article 16, Section 59, of the Texas Constitution, pursuant to the general laws of the State of Texas, including Chapters 49 and 51, Texas Water Code, and pursuant to the provisions of Chapter 268, Acts of 1957, 55th Legislature of Texas, Regular Session, as amended (collectively the "District Act"); and

WHEREAS, the Issuer will authorize the Series 2015A Bonds (hereinafter defined) pursuant to the District Act; and

WHEREAS, by adoption of its Resolution Approving an Application for Financial Assistance, dated _____, 2015, the Texas Water Development Board ("TWDB") has agreed to purchase the Issuer's hereinafter authorized bonds; and

WHEREAS, the meeting was open to the public and public notice of the time, place and purpose of said meeting was given pursuant to Chapter 551, Texas Government Code.

THEREFORE, BE IT RESOLVED BY THE BOARD OF DIRECTORS OF TARRANT REGIONAL WATER DISTRICT, A WATER CONTROL AND IMPROVEMENT DISTRICT, THAT:

Section 1. AMOUNT AND PURPOSE OF THE BONDS. The Bonds will be issued in one or more series, in an aggregate principal amount not to exceed $300,000,000, and in the manner hereinafter provided, for the purpose of obtaining funds (i) to pay for construction, improvements, and extensions to the District's Water System, including design, acquisition, and construction of an integrated pipeline to serve the City of Dallas and the District; (ii) to fund a debt service reserve fund; and (iii) to pay costs of issuance of the Series 2015A Bonds.

Section 2. DESIGNATION OF THE BONDS. Each bond issued pursuant to this Resolution shall be designated: "TARRANT REGIONAL WATER DISTRICT, A WATER CONTROL AND IMPROVEMENT DISTRICT, WATER REVENUE BOND, SERIES 2015A." Initially there shall be issued, sold, and delivered hereunder a single fully registered bond, without interest coupons, payable in installments of principal (the "Initial Bond"), but the Initial Bond may

be assigned and transferred and/or converted into and exchanged for a like aggregate amount of fully registered bonds, without interest coupons, having serial maturities, and in the denomination or denominations of $5,000 or any integral multiple of $5,000, all in the manner hereinafter provided. The term "Series 2015A Bonds" as used in this Resolution shall mean and include collectively the Initial Bond and all substitute bonds exchanged therefor, as well as all other substitute bonds and replacement bonds issued pursuant hereto, and the term "Series 2015A Bond" shall mean any of the Series 2015A Bonds.

Section 3. INITIAL DATE, DENOMINATION, NUMBER, MATURITIES, INITIAL REGISTERED OWNER, AND CHARACTERISTICS OF THE INITIAL BOND. (a) The Initial Bond is hereby authorized to be issued, sold, and delivered hereunder as a single fully registered Bond, without interest coupons, dated _____, 2015, in the denomination and aggregate principal amount of $_____, numbered TR-1, payable in annual installments of principal to the initial registered owner thereof, to-wit: Texas Water Development Board or to the registered assignee or assignees of said Initial Bond or any portion or portions thereof (in each case, the "registered owner"), with the annual installments of principal of the Initial Bond to be payable on the dates, respectively, and in the principal amounts, respectively, stated in the FORM OF INITIAL BOND set forth in this Resolution.

(b) The Initial Bond (i) may be prepaid or paid on the respective scheduled due dates of installments of principal thereof, (ii) may be assigned and transferred, (iii) may be converted and exchanged for other bonds, (iv) shall have the characteristics, and (v) shall be signed and sealed, and the principal of and interest on the Initial Bond shall be payable, all as provided, and in the manner required or indicated, in the FORM OF INITIAL BOND set forth in this Resolution.

Section 4. INTEREST. The unpaid principal balance of the Initial Bond shall bear interest from the date of delivery (the "Issue Date") of the Initial Bond to the TWDB to the respective scheduled due dates, or to the respective dates of prepayment or redemption, if any, of the installments of principal of the Initial Bond, and such interest shall be payable in the manner, at the rates, and on the dates, respectively, as provided in the FORM OF INITIAL BOND set forth in this Resolution.

Section 5. FORM OF INITIAL BOND. The form of the Initial Bond, including the form of Registration Certificate of the Comptroller of Public Accounts of the State of Texas to be endorsed on the Initial Bond, shall be substantially as fol1ows:

FORM OF INITIAL BOND

NO. TR-1 $_____

UNITED STATES OF AMERICA
STATE OF TEXAS
TARRANT REGIONAL WATER DISTRICT,
A WATER CONTROL AND IMPROVEMENT DISTRICT,
WATER REVENUE BOND,
SERIES 2015A

TARRANT REGIONAL WATER DISTRICT, A WATER CONTROL AND IMPROVEMENT DISTRICT (the "Issuer"), being a political subdivision of the State of Texas, hereby promises to pay to TEXAS WATER DEVELOPMENT BOARD (the "TWDB") or to the registered assignee or assignees of this Bond or any portion or portions hereof (in each case, the "registered owner") the aggregate principal amount of _____ _____ in annual installments of principal due and payable on March 1 in each of the years, and in the respective principal amounts, as set forth in the following schedule:

Year	Principal Amount	Year	Principal Amount

and to pay interest, calculated on the basis of a 360-day year composed of twelve 30-day months, from the date of initial delivery of this Bond to the TWDB, on the balance of each such installment of principal, respectively, from time to time remaining unpaid, at the rates as follows:

Year	Rate	Year	Rate

with said interest being payable semiannually on each March 1 and September 1, commencing _____, while this Bond or any portion hereof is outstanding and unpaid.

THE INSTALLMENTS OF PRINCIPAL OF AND THE INTEREST ON this Bond are payable in lawful money of the United States of America, without exchange or collection charges. The installments of principal and the interest on this Bond are payable to the registered owner hereof through the services of BOFK, NA d/b/a Bank of Texas, DALLAS, TEXAS, which is the "Paying Agent/Registrar" for this Bond. Payment of all principal of and interest on this Bond shall be made by the Paying Agent/Registrar to the registered owner hereof on each principal and/or interest payment date by check, dated as of such date, drawn by the Paying Agent/Registrar on, and payable solely from, funds of the Issuer required by the resolution authorizing the issuance of this Bond (the "Bond Resolution") to be on deposit with the Paying Agent/Registrar for such purpose as hereinafter provided; and such check shall be sent by the Paying Agent/Registrar by United States mail, first-class postage prepaid, on each such principal and/or interest payment date, to the registered owner hereof, at the address of the registered owner, as it appeared at the close of business on the 15th day of the month next preceding each such date (the "Record Date") on the Registration Books kept by the Paying Agent/ Registrar, as hereinafter described; provided that, if the TWDB is the registered

owner of this Bond, at the option of the TWDB and at the expense of the Issuer, such payment shall be made by wire transfer pursuant to written directions of the TWDB. The Issuer covenants with the registered owner of this Bond that on or before each principal and/or interest payment date for this Bond it will make available to the Paying Agent/Registrar, from the "Interest and Redemption Fund" created by the Bond Resolution, the amounts required to provide for the payment, in immediately available funds, of all principal of and interest on this Bond, when due.

IF THE DATE for the payment of the principal of or interest on this Bond shall be a Saturday, Sunday, a legal holiday, or a day on which banking institutions in the City where the Paying Agent/Registrar is located are authorized by law or executive order to close, then the date for such payment shall be the next succeeding day which is not such a Saturday, Sunday, legal holiday, or day on which banking institutions are authorized to close; and payment on such date shall have the same force and effect as if made on the original date payment was due.

THIS BOND has been authorized in accordance with the Constitution and laws of the State of Texas in the principal amount of $_____, for the purpose of obtaining funds (i) (i) to pay for construction, improvements, and extensions to the District's Water System, including design, acquisition, and construction of an integrated pipeline to serve the City of Dallas and the District; (ii) to fund a debt service reserve fund; and (iii) to pay costs of issuance of the Series 2015A Bonds.

ON _____ 1, ____, or any date thereafter, the unpaid installments of principal of this Bond may be prepaid or redeemed prior to their scheduled due dates, at the option of the Issuer, with funds derived from any available source, as a whole, or in part, and, if in part, in inverse order of maturity and if less than a whole principal installment is to be called, the Issuer shall direct the Paying Agent/Registrar to call by lot or other customary method of random selection the portion of the principal installment to be redeemed (only in an integral multiple of $5,000), at the redemption price of the principal amount to be prepaid or redeemed, plus accrued interest to the date fixed for prepayment or redemption.

AT LEAST 30 days prior to the date fixed for any such prepayment or redemption a written notice of such prepayment or redemption shall be mailed by the Paying Agent/Registrar to the registered owner hereof. By the date fixed for any such prepayment or redemption due provision shall be made by the Issuer with the Paying Agent/Registrar for the payment of the required prepayment or redemption price for this Bond or the portion hereof which is to be so prepaid or redeemed, plus accrued interest thereon to the date fixed for prepayment or redemption. If such written notice of prepayment or redemption is given, and if due provision for such payment is made, all as provided above, this Bond, or the portion thereof which is to be so prepaid or redeemed, thereby automatically shall be treated as prepaid or redeemed prior to its scheduled due date, and shall not bear interest after the date fixed for its prepayment or redemption, and shall not be regarded as being outstanding except for the right of the registered owner to receive the prepayment or redemption price plus accrued interest to the date fixed for prepayment or redemption from the Paying Agent/Registrar out of the funds provided for such payment. The Paying Agent/Registrar shall record in the Registration Books all such prepayments or redemptions of principal of this Bond or any portion hereof.

THIS BOND, to the extent of the unpaid principal balance hereof, or any unpaid portion hereof in any integral multiple of $5,000, may be assigned by the initial registered owner hereof and shall be transferred only in the Registration Books of the Issuer kept by the Paying Agent/Registrar acting in the capacity of registrar for the Bonds, upon the terms and conditions set forth in the Bond Resolution. Among other requirements for such transfer, this Bond must be presented and surrendered to the Paying Agent/ Registrar for cancellation, together with proper instruments of assignment, in form and with guarantee of signatures satisfactory to the Paying Agent/Registrar, evidencing assignment by the initial registered owner of this Bond, or any portion or portions hereof in any integral multiple of $5,000, to the assignee or assignees in whose name or names this Bond or any such portion or portions hereof is or are to be transferred and registered. Any instrument or instruments of assignment satisfactory to the Paying Agent/Registrar may be used to evidence the assignment of this Bond or any such portion or portions hereof by the initial registered owner hereof. A new bond or bonds payable to such assignee or assignees (which then will be the new registered owner or owners of such new Bond or Bonds) or to the initial registered owner as to any portion of this Bond which is not being assigned and transferred by the initial registered owner, shall be delivered by the Paying Agent/Registrar in conversion of and exchange for this Bond or any portion or portions hereof, but solely in the form and manner as provided in the next paragraph hereof for the conversion and exchange of this Bond or any portion hereof. The registered owner of this Bond shall be deemed and treated by the Issuer and the Paying Agent/Registrar as the absolute owner hereof for all purposes, including payment and discharge of liability upon this Bond to the extent of such payment, and the Issuer and the Paying Agent/Registrar shall not be affected by any notice to the contrary.

AS PROVIDED above and in the Bond Resolution, this Bond, to the extent of the unpaid principal balance hereof, may be converted into and exchanged for a like aggregate principal amount of fully registered bonds, without interest coupons, payable to the assignee or assignees duly designated in writing by the initial registered owner hereof, or to the initial registered owner as to any portion of this Bond which is not being assigned and transferred by the initial registered owner, in any denomination or denominations in any integral multiple of $5,000 (subject to the requirement hereinafter stated that each substitute bond issued in exchange for any portion of this Bond shall have a single stated principal maturity date), upon surrender of this Bond to the Paying Agent/Registrar for cancellation, all in accordance with the form and procedures set forth in the Bond Resolution. If this Bond or any portion hereof is assigned and transferred or converted each bond issued in exchange for any portion hereof shall have a single stated principal maturity date corresponding to the due date of the installment of principal of this Bond or portion hereof for which the substitute bond is being exchanged, and shall bear interest at the rate applicable to and borne by such installment of principal or portion thereof. Such bonds, respectively, shall be subject to redemption prior to maturity on the same dates and for the same prices as the corresponding installment of principal of this Bond or portion hereof for which they are being exchanged. No such bond shall be payable in installments, but shall have only one stated principal maturity date. AS PROVIDED IN THE BOND RESOLUTION, THIS BOND IN ITS PRESENT FORM MAY BE ASSIGNED AND TRANSFERRED OR CONVERTED ONCE ONLY, and to one or more assignees, but the bonds issued and delivered in exchange for this Bond or any portion hereof may be assigned and transferred, and converted, subsequently, as provided in the Bond Resolution. The Issuer shall pay the Paying Agent/Registrar's standard or customary fees and charges for transferring, converting, and exchanging this Bond or any portion thereof, but the one requesting

such transfer, conversion, and exchange shall pay any taxes or governmental charges required to be paid with respect thereto. The Paying Agent/Registrar shall not be required to make any such assignment, conversion, or exchange (i) during the period commencing with the close of business on any Record Date and ending with the opening of business on the next following principal or interest payment date, or, (ii) with respect to any Bond or portion thereof called for prepayment or redemption prior to maturity, within 45 days prior to its prepayment or redemption date.

IN THE EVENT any Paying Agent/Registrar for this Bond is changed by the Issuer, resigns, or otherwise ceases to act as such, the Issuer has covenanted in the Bond Resolution that it promptly will appoint a competent and legally qualified substitute therefor, and promptly will cause written notice thereof to be mailed to the registered owner of this Bond.

IT IS HEREBY certified, recited, and covenanted that this Bond has been duly and validly authorized, issued, and delivered; that all acts, conditions, and things required or proper to be performed, exist, and be done precedent to or in the authorization, issuance, and delivery of this Bond have been performed, existed, and been done in accordance with law; that this Bond and the interest thereon, are special obligations of the Issuer which, together with other outstanding bonds of the Issuer, are secured by and payable equally and ratably on a parity from a first lien on and pledge of the "Pledged Revenues," as defined in the Bond Resolution, which include the "Net Revenues of the District's Water System," as defined in the Bond Resolution, which specifically include certain amounts to be received by the Issuer (i) pursuant to the "Tarrant County Regional Water Supply Facilities Contract," dated August 29, 1979, among the Issuer and the Cities of Fort Worth and Mansfield, Texas, the "Tarrant County Regional Water Supply Facilities Supplemental Contract For Trinity River Authority of Texas," dated as of March 12, 1979 between the Issuer and Trinity River Authority of Texas, and the "Tarrant County Regional Water Supply Facilities Amendatory Contract", dated September 1, 1982, among the Issuer, the Cities of Fort Worth, Arlington, and Mansfield, Texas, and Trinity River Authority of Texas, which last named amendatory contract consolidates the previous contracts between such parties with respect to the Issuer's Water System into one instrument and sets forth the entire agreement between such parties with respect to the Issuer's Water System, and (ii) pursuant to contracts with other water customers of the Issuer.

THE ISSUER has reserved the right, subject to the restrictions stated in the Bond Resolution, to issue Additional Bonds payable from and secured by a first lien on and pledge of the "Pledged Revenues" on a parity with this Bond.

THE ISSUER also has reserved the right to amend the Bond Resolution, with the approval of the owners of 51% of the outstanding bonds secured by a first lien on the Pledged Revenues, subject to the restrictions as stated in the Bond Resolution.

THE REGISTERED OWNER hereof shall never have the right to demand payment of this Bond or the interest hereon out of any funds raised or to be raised by taxation or from any source whatsoever other than specified in the Bond Resolution.

BY BECOMING the registered owner of this Bond, the registered owner thereby acknowledges all of the terms and provisions of the Bond Resolution, agrees to be bound by such

terms and provisions, acknowledges that the Bond Resolution is duly recorded and available for inspection in the official minutes and records of the governing body of the Issuer, and agrees that the terms and provisions of this Bond and the Bond Resolution constitute a contract between the registered owner hereof and the Issuer.

IN WITNESS WHEREOF, the Issuer has caused this Bond to be signed with the manual or facsimile signature of the President of the Board of Directors of the Issuer and countersigned with the manual or facsimile signature of the Secretary of the Board of Directors of the Issuer, has caused the official seal of the Issuer to be duly impressed, or placed in facsimile, on this Bond and has caused this Bond to be dated as of _____, 2015.

xxxxxxx	xxxxxxx
Secretary, Board of Directors	President, Board of Directors

(DISTRICT SEAL)

FORM OF REGISTRATION CERTIFICATE OF THE
COMPTROLLER OF PUBLIC ACCOUNTS:

COMPTROLLER'S REGISTRATION CERTIFICATE: REGISTER NO.

I hereby certify that this Bond has been examined, certified as to validity, and approved by the Attorney General of the State of Texas, and that this Bond has been registered by the Comptroller of Public Accounts of the State of Texas.

Witness my signature and seal this

_____
Comptroller of Public Accounts of the State of Texas

(COMPTROLLER'S SEAL)

Section 6. CHARACTERISTICS OF THE SERIES 2015A BONDS. (a) Registration, Transfer, Conversion and Exchange; Authentication. (a) The Issuer shall keep or cause to be kept at the principal corporate trust office of BOFK, NA d/b/a Bank of Texas, Dallas, Texas (the "Paying Agent/Registrar") books or records for the registration of the transfer, conversion and exchange of the Series 2015A Bonds (the "Registration Books"), and the Issuer hereby appoints the Paying Agent/Registrar as its registrar and transfer agent to keep such books or records and make such registrations of transfers, conversions and exchanges under such reasonable regulations as the Issuer and Paying Agent/Registrar may prescribe; and the Paying Agent/Registrar shall make such registrations, transfers, conversions and exchanges as herein provided. The Paying Agent/Registrar shall obtain and record in the Registration Books the address of the registered owner of each Series 2015A Bond to which payments with respect to the Series 2015A Bonds shall be mailed, as herein provided; but it shall be the duty of each registered owner to notify the Paying Agent/Registrar in writing of the address to which payments shall be mailed, and such interest payments shall not be mailed unless such notice has been given. To the extent possible and under reasonable

circumstances, all transfers of Series 2015A Bonds shall be made within three business days after request and presentation thereof. The Issuer shall have the right to inspect the Registration Books during regular business hours of the Paying Agent/Registrar, but otherwise the Paying Agent/Registrar shall keep the Registration Books confidential and, unless otherwise required by law, shall not permit their inspection by any other entity. The Paying Agent/Registrar's standard or customary fees and charges for making such registration, transfer, conversion, exchange and delivery of a substitute Series 2015A Bond or Series 2015A Bonds shall be paid as provided in the FORM OF SERIES 2015A BOND set forth in this Resolution. Registration of assignments, transfers, conversions and exchanges of Series 2015 Bonds shall be made in the manner provided and with the effect stated in the FORM OF SERIES 2015A BOND set forth in this Resolution. Each substitute Series 2015A Bond shall bear a letter and/or number to distinguish it from each other Series 2015A Bond.

An authorized representative of the Paying Agent/Registrar shall, before the delivery of any such Series 2015A Bond, date and manually sign the Paying Agent/Registrar's Authentication Certificate, and no such Series 2015A Bond shall be deemed to be issued or outstanding unless such Certificate is so executed. The Paying Agent/Registrar promptly shall cancel all paid Series 2015A Bonds surrendered for conversion and exchange. No additional ordinances, orders, or resolutions need be passed or adopted by the governing body of the Issuer or any other body or person so as to accomplish the foregoing conversion and exchange of any Series 2015A Bond or portion thereof, and the Paying Agent/Registrar shall provide for the printing, execution, and delivery of the substitute Series 2015A Bonds in the manner prescribed herein, and said Series 2015A Bonds shall be of type composition printed on paper of customary weight and strength. Pursuant to Subchapter D, Chapter 1201, Texas Government Code, the duty of conversion and exchange of Series 2015A Bonds as aforesaid is hereby imposed upon the Paying Agent/Registrar, and, upon the execution of said Certificate, the converted and exchanged Series 2015A Bond shall be valid, incontestable, and enforceable in the same manner and with the same effect as the Series 2015A Bonds which initially were issued and delivered pursuant to this Resolution, approved by the Attorney General, and registered by the Comptroller of Public Accounts.

(b) Payment of Series 2015A Bonds and Interest. The Issuer hereby further appoints the Paying Agent/Registrar to act as the paying agent for paying the principal of and interest on the Series 2015A Bonds, all as provided in this Resolution. The Paying Agent/Registrar shall keep proper records of all payments made by the Issuer and the Paying Agent/Registrar with respect to the Series 2015A Bonds.

(c) In General. The Series 2015A Bonds (i) shall be issued in fully registered form, without interest coupons, with the principal of and interest on such Series 2015A Bonds to be payable only to the registered owners thereof, (ii) may be redeemed prior to their scheduled maturities, (iii) may be transferred and assigned, (iv) may be converted and exchanged for other Series 2015A Bonds, (v) shall have the characteristics, (vi) shall be signed, sealed, executed and authenticated, (vii) shall be payable as to principal and interest, and (viii) shall be administered and the Paying Agent/Registrar and the Issuer shall have certain duties and responsibilities with respect to the Series 2015A Bonds, all as provided, and in the manner and to the effect as required or indicated, in the FORM OF SERIES 2015A BOND set forth in this Resolution. The Series 2015A Bonds initially issued and delivered pursuant to this Resolution are not required to be, and shall not be,

authenticated by the Paying Agent/Registrar, but on each substitute Series 2015A Bond issued in conversion of and exchange for any Series 2015A Bond or Series 2015A Bonds issued under this Resolution the Paying Agent/Registrar shall execute the PAYING AGENT/REGISTRAR'S AUTHENTICATION CERTIFICATE, in the form set forth in the FORM OF SERIES 2015A BOND.

(d) Substitute Paying Agent/Registrar. The Issuer covenants with the registered owners of the Series 2015A Bonds that at all times while the Series 2015A Bonds are outstanding the Issuer will provide a competent and legally qualified bank, trust company, financial institution, or other agency to act as and perform the services of Paying Agent/Registrar for the Series 2015A Bonds under this Resolution, and that the Paying Agent/Registrar will be one entity. The Issuer reserves the right to, and may, at its option, change the Paying Agent/Registrar upon not less than 120 days written notice to the Paying Agent/Registrar, to be effective not later than 60 days prior to the next principal or interest payment date after such notice. In the event that the entity at any time acting as Paying Agent/Registrar (or its successor by merger, acquisition, or other method) should resign or otherwise cease to act as such, the Issuer covenants that promptly it will appoint a competent and legally qualified bank, trust company, financial institution, or other agency to act as Paying Agent/Registrar under this Resolution. Upon any change in the Paying Agent/Registrar, the previous Paying Agent/Registrar promptly shall transfer and deliver the Registration Books (or a copy thereof), along with all other pertinent books and records relating to the Series 2015A Bonds, to the new Paying Agent/Registrar designated and appointed by the Issuer. Upon any change in the Paying Agent/Registrar, the Issuer promptly will cause a written notice thereof to be sent by the new Paying Agent/Registrar to each registered owner of the Series 2015A Bonds, by United States mail, first-class postage prepaid, which notice also shall give the address of the new Paying Agent/Registrar. By accepting the position and performing as such, each Paying Agent/Registrar shall be deemed to have agreed to the provisions of this Resolution, and a certified copy of this Resolution shall be delivered to each Paying Agent/Registrar.

(e) Reporting Requirements of Paying Agent/Registrar. To the extent required by the Code and the regulations promulgated and pertaining thereto, it shall be the duty of the Paying Agent/Registrar, on behalf of the Issuer, to report to the owners of the Series 2015A Bonds and the Internal Revenue Service (i) the amount of "reportable payments," if any, subject to backup withholding during each year and the amount of tax withheld, if any, with respect to payments of the Series 2015A Bonds and (ii) the amount of interest or amount treated as interest on the Series 2015A Bonds and required to be included in gross income of the owner thereof.

(f) Book-Entry Only System. The Series 2015A Bonds issued in exchange for the Initial Bond shall be initially issued in the form of a separate single fully registered Series 2015A Bond for each of the maturities thereof. Upon initial issuance, the ownership of each such Series 2015A Bond shall be registered in the name of Cede & Co., as nominee of Depository Trust Company of New York ("DTC"), and except as provided in subsection (f) hereof, all of the outstanding Series 2015A Bonds shall be registered in the name of Cede & Co., as nominee of DTC.

With respect to Series 2015A Bonds registered in the name of Cede & Co., as nominee of DTC, the Issuer and the Paying Agent/Registrar shall have no responsibility or obligation to any DTC Participant or to any person on behalf of whom such a DTC Participant holds an interest on

the Series 2015A Bonds. Without limiting the immediately preceding sentence, the Issuer and the Paying Agent/Registrar shall have no responsibility or obligation with respect to (i) the accuracy of the records of DTC, Cede & Co. or any DTC Participant with respect to any ownership interest in the Series 2015A Bonds, (ii) the delivery to any DTC Participant or any other person, other than a Bondholder, as shown on the Registration Books, of any notice with respect to the Series 2015A Bonds, including any notice of redemption, or (iii) the payment to any DTC Participant or any other person, other than a Bondholder, as shown in the Registration Books of any amount with respect to principal of, premium, if any, or interest on, as the case may be, the Series 2015A Bonds. Notwithstanding any other provision of this Resolution to the contrary, the Issuer and the Paying Agent/Registrar shall be entitled to treat and consider the person in whose name each Series 2015A Bond is registered in the Registration Books as the absolute owner of such Series 2015A Bond for the purpose of payment of principal, premium, if any, and interest, as the case may be, with respect to such Series 2015A Bond, for the purpose of giving notices of redemption and other matters with respect to such Series 2015A Bond, for the purpose of registering transfers with respect to such Series 2015A Bond, and for all other purposes whatsoever. The Paying Agent/Registrar shall pay all principal of and interest on the Series 2015A Bonds only to or upon the order of the respective owners, as shown in the Registration Books as provided in this Resolution, or their respective attorneys duly authorized in writing, and all such payments shall be valid and effective to fully satisfy and discharge the Issuer's obligations with respect to payment of principal of, premium, if any, and interest on, or as the case may be, the Series 2015A Bonds to the extent of the sum or sums so paid. No person other than an owner, as shown in the Registration Books, shall receive a Series 2015A Bond certificate evidencing the obligation of the Issuer to make payments of principal, premium, if any, and interest, as the case may be, pursuant to this Resolution. Upon delivery by DTC to the Paying Agent/Registrar of written notice to the effect that DTC has determined to substitute a new nominee in place of Cede & Co., and subject to the provisions in this Resolution with respect to interest checks being mailed to the registered owner at the close of business on the Record Date, the word "Cede & Co." in this Resolution shall refer to such new nominee of DTC.

(g) Successor Securities Depository; Transfers Outside Book-Entry Only System. In the event that the Issuer or the Paying Agent/Registrar determines that DTC is incapable of discharging its responsibilities described herein and in the representation letter of the Issuer to DTC and that it is in the best interest of the beneficial owners of the Series 2015A Bonds that they be able to obtain certificated Series 2015A Bonds, the Issuer or the Paying Agent/Registrar shall (i) appoint a successor securities depository, qualified to act as such under Section 17(a) of the Securities and Exchange Act of 1934, as amended, notify DTC and DTC Participants of the appointment of such successor securities depository and transfer one or more separate Series 2015A Bonds to such successor securities depository or (ii) notify DTC and DTC Participants of the availability through DTC of Series 2015A Bonds and transfer one or more separate Series 2015A Bonds to DTC Participants having Series 2015A Bonds credited to their DTC accounts. In such event, the Series 2015A Bonds shall no longer be restricted to being registered in the Registration Books in the name of Cede & Co., as nominee of DTC, but may be registered in the name of the successor securities depository, or its nominee, or in whatever name or names Bondholders transferring or exchanging Series 2015A Bonds shall designate, in accordance with the provisions of this Resolution.

(h) Payments to Cede & Co. Notwithstanding any other provision of this Resolution to the contrary, so long as any Series 2015A Bond is registered in the name of Cede & Co., as nominee

of DTC, all payments with respect to principal of, premium, if any, and interest on, or as the case may be, such Series 2015A Bond and all notices with respect to such Series 2015A Bond shall be made and given, respectively, in the manner provided in the representation letter of the Issuer to DTC.

Section 7. FORM OF SERIES 2015A SUBSTITUTE BONDS. The form of all Series 2015A Bonds issued in conversion and exchange or replacement of any other Series 2015A Bond or portion thereof, including the form of Paying Agent/Registrar's Certificate to be printed on each of such Series 2015A Bonds, and the Form of Assignment to be printed on each of the Series 2015A Bonds, shall be, respectively, substantially as follows, with such appropriate variations, omissions, or insertions as are permitted or required by this Resolution.

FORM OF SERIES 2015A SUBSTITUTE BOND

NO.____ PRINCIPAL AMOUNT
$_____

UNITED STATES OF AMERICA
STATE OF TEXAS
TARRANT REGIONAL WATER DISTRICT,
A WATER CONTROL AND IMPROVEMENT DISTRICT,
WATER REVENUE BOND,
SERIES 2015A

INTEREST RATE	MATURITY DATE	ISSUE DATE	CUSIP NO.
%	March 1, ____	_____, 2015	

ON THE MATURITY DATE specified above TARRANT REGIONAL WATER DISTRICT, A WATER CONTROL AND IMPROVEMENT DISTRICT (the "Issuer"), being a political subdivision of the State of Texas, hereby promises to pay to CEDE & CO. or to the registered assignee hereof (either being hereinafter called the "registered owner") the principal amount of _____ DOLLARS and to pay interest thereon, calculated on the basis of a 360-day year composed of twelve 30-day months, from the Issue Date specified above, to the Maturity Date specified above, or the date of redemption prior to maturity, at the interest rate per annum specified above; with interest being payable semiannually on each March 1 and September 1, commencing _____, except that if the date of authentication of this Bond is later than the first Record Date (hereinafter defined), such principal amount shall bear interest from the interest payment date next preceding the date of authentication, unless such date of authentication is after any Record Date (hereinafter defined) but on or before the next following interest payment date, in which case such principal amount shall bear interest from such next following interest payment date.

THE PRINCIPAL OF AND INTEREST ON this Bond are payable in lawful money of the United States of America, without exchange or collection charges. The principal of this Bond shall

be paid to the registered owner hereof upon presentation and surrender of this Bond at maturity or upon the date fixed for its redemption prior to maturity, at the principal corporate trust office of BOFK, NA d/b/a Bank of Texas, Dallas, Texas, which is the "Paying Agent/Registrar" for this Bond. The payment of interest on this Bond shall be made by the Paying Agent/Registrar to the registered owner hereof on each interest payment date by check dated as of such interest payment date, drawn by the Paying Agent/Registrar on, and payable solely from, funds of the Issuer required by the resolution authorizing the issuance of the Bonds (the "Bond Resolution") to be on deposit with the Paying Agent/Registrar for such purpose as hereinafter provided; and such check shall be sent by the Paying Agent/Registrar by United States mail, first-class postage prepaid, on each such interest payment date, to the registered owner hereof, at the address of the registered owner, as it appeared at the close of business on the 15th day of the month next preceding each such date (the "Record Date") on the Registration Books kept by the Paying Agent/Registrar, as hereinafter described; provided, however, for Bonds, the registered owner of which is the Texas Water Development Board (the "TWDB"), at the option of the TWDB and at the expense of the Issuer, such payment shall be made by wire transfer pursuant to written directions of the TWDB. However, notwithstanding the foregoing provisions, (1) the payment of such interest may be made by any other method acceptable to the Paying Agent/Registrar and requested by, and at the risk and expense of, the registered owner hereof and (2) upon the written request, and at the risk and expense of, the registered owner of any Bond of this Series in the amount of $1,000,000 or more, delivered to the Paying Agent/Registrar not less than 15 days prior to any interest payment date, payment of the interest due on such Bond on such date shall be paid on such date by wire transfer to any designated account in the United States of America which has available to it the wire service facilities of the Federal Reserve Bank. Any accrued interest due upon the redemption of this Bond prior to maturity as provided herein shall be paid to the registered owner at the principal corporate trust office of the Paying Agent/Registrar upon presentation and surrender of this Bond for redemption and payment at the principal corporate trust office of the Paying Agent/Registrar. The Issuer covenants with the registered owner of this Bond that on or before each principal payment date, interest payment date, and accrued interest payment date for this Bond it will make available to the Paying Agent/Registrar, from the "Interest and Redemption Fund" created by the Bond Resolution, the amounts required to provide for the payment, in immediately available funds, of all principal of and interest on the Bonds, when due.

IF THE DATE for the payment of the principal of or interest on this Bond shall be a Saturday, Sunday, a legal holiday, or a day on which banking institutions in the City where the Paying Agent/Registrar is located are authorized by law or executive order to close, then the date for such payment shall be the next succeeding day which is not such a Saturday, Sunday, legal holiday, or day on which banking institutions are authorized to close; and payment on such date shall have the same force and effect as if made on the original date payment was due.

THIS BOND is one of an issue of bonds (the "Bonds") dated as of _____, 2015, authorized in accordance with the Constitution and laws of the State of Texas in the principal amount of $_____ for the purpose of obtaining funds (i) to pay for construction, improvements, and extensions to the District's Water System, including design, acquisition, and construction of an integrated pipeline to serve the City of Dallas and the District; (ii) to fund a debt service reserve fund; and (iii) to pay costs of issuance of the Bonds.

ON _____ 1, ____, or any date thereafter, the outstanding Bonds may be redeemed prior to their scheduled maturities, at the option of the Issuer, with funds derived from any available

source, as a whole, or in part, and, if in part, the Issuer shall select and designate the maturity, or maturities, and the amount that is to be redeemed, and if less than a whole maturity is to be redeemed, the Issuer shall direct the Paying Agent/Registrar to call by lot or other customary method of random selection the Bonds or portions thereof to be redeemed (provided that the Bonds to be redeemed only in integral multiples of $5,000), at the redemption price of the principal amount of the Bonds to be redeemed, plus accrued interest to the date fixed for redemption.

DURING ANY PERIOD in which ownership of the Bonds is determined by a book entry at a securities depository for the Bonds, if fewer than all of the Bonds of the same maturity and bearing the same interest rate are to be redeemed, the particular Bonds of such maturity and bearing such interest rate shall be selected in accordance with the arrangements between the Issuer and the securities depository.

AT LEAST 30 days prior to the date fixed for any redemption of Bonds or portions thereof prior to maturity at the option of the Issuer, a written notice of such redemption shall be sent by the Paying Agent/Registrar by United States mail, first-class postage prepaid, to the registered owner appearing on the Registration Books at the close of business on the day next preceding the date of mailing of such notice; provided, however, that any notice so mailed shall be conclusively presumed to have been duly given and the failure to receive such notice, or any defect therein shall not affect the validity or effectiveness of the proceedings for the redemption of any Bond at the option of the Issuer. By the date fixed for any such redemption due provision shall be made with the Paying Agent/Registrar for the payment of the required redemption price for the Bonds or portions thereof which are to be so redeemed, plus accrued interest thereon to the date fixed for redemption. If such written notice of redemption is mailed and if due provision for such payment is made, all as provided above, the Bonds or portions thereof which are to be so redeemed thereby automatically shall be treated as redeemed prior to their scheduled maturities, and they shall not bear interest after the date fixed for redemption, and they shall not be regarded as being outstanding except for the right of the registered owner to receive the redemption price plus accrued interest from the Paying Agent/Registrar out of the funds provided for such payment. If a portion of any Bond shall be redeemed a substitute Bond or Bonds having the same maturity date, bearing interest at the same rate, in any denomination or denominations in any integral multiple of $5,000, at the written request of the registered owner, and in aggregate principal amount equal to the unredeemed portion thereof, will be issued to the registered owner upon the surrender thereof for cancellation, at the expense of the Issuer, all as provided in the Bond Resolution.

THIS BOND OR ANY PORTION OR PORTIONS HEREOF IN ANY INTEGRAL MULTIPLE OF $5,000 may be assigned and shall be transferred only in the Registration Books of the Issuer kept by the Paying Agent/Registrar acting in the capacity of registrar for the Bonds, upon the terms and conditions set forth in the Bond Resolution. Among other requirements for such assignment and transfer, this Bond must be presented and surrendered to the Paying Agent/Registrar, together with proper instruments of assignment, in form and with guarantee of signatures satisfactory to the Paying Agent/Registrar, evidencing assignment of this Bond or any portion or portions hereof in any integral multiple of $5,000 to the assignee or assignees in whose name or names this Bond or any such portion or portions hereof is or are to be transferred and registered. The form of Assignment printed or endorsed on this Bond shall be executed by the registered owner or its duly authorized attorney or representative, to evidence the assignment hereof. A new Bond or Bonds payable to such assignee or assignees (which then will be the new registered owner or owners

of such new Bond or Bonds), or to the previous registered owner in the case of the assignment and transfer of only a portion of this Bond, may be delivered by the Paying Agent/Registrar in conversion of and exchange for this Bond, all in the form and manner as provided in the next paragraph hereof for the conversion and exchange of other Bonds. The Issuer shall pay the Paying Agent/Registrar's standard or customary fees and charges for making such transfer, but the one requesting such transfer shall pay any taxes or other governmental charges required to be paid with respect thereto. The Paying Agent/Registrar shall not be required to make transfers of registration of this Bond or any portion hereof (i) during the period commencing with the close of business on any Record Date and ending with the opening of business on the next following principal or interest payment date, or, (ii) with respect to any Bond or any portion thereof called for redemption prior to maturity, within 45 days prior to its redemption date. The registered owner of this Bond shall be deemed and treated by the Issuer and the Paying Agent/Registrar as the absolute owner hereof for all purposes, including payment and discharge of liability upon this Bond to the extent of such payment, and the Issuer and the Paying Agent/Registrar shall not be affected by any notice to the contrary.

ALL BONDS OF THIS SERIES are issuable solely as fully registered bonds, without interest coupons, in the denomination of any integral multiple of $5,000. As provided in the Bond Resolution, this Bond, or any unredeemed portion hereof, may, at the request of the registered owner or the assignee or assignees hereof, be converted into and exchanged for a like aggregate principal amount of fully registered bonds, without interest coupons, payable to the appropriate registered owner, assignee, or assignees, as the case may be, having the same maturity date, and bearing interest at the same rate, in any denomination or denominations in any integral multiple of $5,000 as requested in writing by the appropriate registered owner, assignee, or assignees, as the case may be, upon surrender of this Bond to the Paying Agent/Registrar for cancellation, all in accordance with the form and procedures set forth in the Bond Resolution. The Issuer shall pay the Paying Agent/Registrar's standard or customary fees and charges for transferring, converting, and exchanging any Bond or any portion thereof, but the one requesting such transfer, conversion, and exchange shall pay any taxes or governmental charges required to be paid with respect thereto as a condition precedent to the exercise of such privilege of conversion and exchange. The Paying Agent/Registrar shall not be required to make any such conversion and exchange (i) during the period commencing with the close of business on any Record Date and ending with the opening of business on the next following principal or interest payment date, or, (ii) with respect to any Bond or portion thereof called for redemption prior to maturity, within 45 days prior to its redemption date.

IN THE EVENT any Paying Agent/Registrar for the Bonds is changed by the Issuer, resigns, or otherwise ceases to act as such, the Issuer has covenanted in the Bond Resolution that it promptly will appoint a competent and legally qualified substitute therefor, and promptly will cause written notice thereof to be mailed to the registered owners of the Bonds.

IT IS HEREBY certified, recited, and covenanted that this Bond has been duly and validly authorized, issued, and delivered; that all acts, conditions, and things required or proper to be performed, exist, and be done precedent to or in the authorization, issuance, and delivery of this Bond have been performed, existed, and been done in accordance with law; that this Bond and the interest thereon, are special obligations of the Issuer which, together with other outstanding bonds of the Issuer, are secured by and payable equally and ratably on a parity from a first lien on and

pledge of the "Pledged Revenues," as defined in the Bond Resolution, which include the "Net Revenues of the District's Water System," as defined in the Bond Resolution, which specifically include certain amounts to be received by the Issuer (i) pursuant to the "Tarrant County Regional Water Supply Facilities Contract", dated August 29, 1979, among the Issuer and the Cities of Fort Worth and Mansfield, Texas, the "Tarrant County Regional Water Supply Facilities Supplemental Contract For Trinity River Authority of Texas," dated as of March 12, 1979 between the Issuer and Trinity River Authority of Texas, and the "Tarrant County Regional Water Supply Facilities Amendatory Contract," dated September 1, 1982, among the Issuer, the Cities of Fort Worth, Arlington, and Mansfield, Texas, and Trinity River Authority of Texas, which last named amendatory contract consolidates the previous contracts between such parties with respect to the Issuer's Water System into one instrument and sets forth the entire agreement between such parties with respect to the Issuer's Water System, and (ii) pursuant to contracts with other water customers of the Issuer.

THE ISSUER has reserved the right, subject to the restrictions stated in the Bond Resolution, to issue Additional Bonds payable from and secured by a first lien on and pledge of the "Pledged Revenues" on a parity with this Bond.

THE ISSUER also has reserved the right to amend the Bond Resolution, with the approval of the owners of 51% of the outstanding bonds secured by a first lien on the Pledged Revenues, subject to the restrictions stated in the Bond Resolution.

THE REGISTERED OWNER hereof shall never have the right to demand payment of this Bond or the interest hereon out of any funds raised or to be raised by taxation or from any source whatsoever other than as specified in the Bond Resolution.

BY BECOMING the registered owner of this Bond, the registered owner thereby acknowledges all of the terms and provisions of the Bond Resolution, agrees to be bound by such terms and provisions, acknowledges that the Bond Resolution is duly recorded and available for inspection in the official minutes and records of the governing body of the Issuer, and agrees that the terms and provisions of this Bond and the Bond Resolution constitute a contract between each registered owner hereof and the Issuer.

IN WITNESS WHEREOF, the Issuer has caused this Bond to be signed with the facsimile signature of the President of the Board of Directors of the Issuer and countersigned with the facsimile signature of the Secretary of the Board of Directors of the Issuer, and has caused the official seal of the Issuer to be duly impressed, or placed in facsimile, on this Bond.

xxxxxxx	xxxxxxx
Secretary, Board of Directors	President, Board of Directors

(DISTRICT SEAL)

FORM OF PAYING AGENT/REGISTRAR'S AUTHENTICATION CERTIFICATE

PAYING AGENT/REGISTRAR'S AUTHENTICATION CERTIFICATE

(To be executed if this Bond is not accompanied by an executed Registration Certificate of the Comptroller of Public Accounts of the State of Texas)

It is hereby certified that this Bond has been issued under the provisions of the Bond Resolution described in the text of this Bond; and that this Bond has been issued in conversion or replacement of, or in exchange for, a bond, bonds, or a portion of a bond or bonds of a Series which originally was approved by the Attorney General of the State of Texas and registered by the Comptroller of Public Accounts of the State of Texas.

Dated

BOFK, NA d/b/a BANK OF TEXAS,
Dallas, Texas

By _____
Authorized Representative

FORM OF ASSIGNMENT

ASSIGNMENT

FOR VALUE RECEIVED, the undersigned sells, assigns and transfers unto

Please Insert Social Security or
Other Identifying Number of Assignee
/_____/

_____
(Name and Address of Assignee)
the within Bond and does hereby irrevocably constitute and appoint _____ to transfer said Bond on the books kept for registration thereof with full power of substitution in the premises.

Date: _____

_____

Signature Guaranteed: _____

NOTICE: The signature to this assignment must correspond with the name as it appears upon the face of the within Bond in every particular, without alteration or enlargement or any change whatever; and

NOTICE: Signature(s) must be guaranteed by an eligible guarantor institution participating in a Securities Transfer Association recognized signature guarantee program.

Section 8. ADDITIONAL DEFINITIONS. In addition to the definitions heretofore provided for, the following terms as used in this Resolution shall have the meanings set forth below, unless the text hereof specifically indicates otherwise:

The term "Additional Bonds" shall mean the additional parity revenue bonds permitted to be authorized in the future on a parity with the Bonds, as hereinafter provided in Sections 21 and 22 hereof.

The term "Board" shall mean the Board of Directors of the District, being the governing body of the District, and it is further resolved that the declarations and covenants of the District contained in this Resolution are made by, and for and on behalf of the Board and the District, and are binding upon the Board and the District for all purposes.

The terms "Bond Resolution" and "Resolution" shall mean this resolution authorizing the Series 2015A Bonds; and it is hereby resolved and provided that Sections 8 through 24 of this Bond Resolution are applicable to all of the Bonds, as hereinafter defined, and substantially restate and are supplemental to and cumulative of Sections 8 through 24 of each of the Series 2008A Bond Resolution, Series 2008B Bond Resolution, Series 2009 Bond Resolution, Series 2010 Bond Resolution, Series 2010A Bond Resolution, Series 2010B Bond Resolution, Series 2012 Bond Resolution, Series 2012A Bond Resolution, the Series 2014 Bond Resolution, and the Series 2015 Bond Reoslution with the appropriate changes and additions which are required with respect to the issuance of the Series 2015A Bonds.

The term "Bonds" shall mean collectively (i) the unpaid and unrefunded Series 2008A Bonds, Series 2008B Bonds, Series 2009 Bonds, Series 2010 Bonds, Series 2010A Bonds, Series 2010B Bonds, Series 2012 Bonds, Series 2012A Bonds, the Series 2014 Bonds, and the Series 2015 Bonds to be outstanding at any time after the delivery of the Initial Bond, and (ii) the Series 2015A Bonds.

The term "Code" shall mean the Internal Revenue Code of 1986, as amended.

The term "Contracts" shall mean collectively: (a) the "Tarrant County Regional Water Supply Facilities Contract", dated as of August 29, 1979, among the District and the Cities of Fort Worth and Mansfield, Texas, the "Tarrant County Regional Water Supply Facilities Supplemental Contract For Trinity River Authority of Texas", dated as of March 12, 1979, between the District and Trinity River Authority of Texas, and the "Tarrant County Regional Water Supply Facilities Amendatory Contract", dated September 1, 1982, among the District, the Cities of Fort Worth, Arlington, and Mansfield, Texas, and Trinity River Authority of Texas, which last named amendatory contract consolidates the previous contracts between such parties with respect to the System into one instrument and sets forth the entire agreement between such parties with respect to the System; and (b) all water supply contracts heretofore or hereafter executed between the District and other cities and customers in connection with the District's Water System.

The terms "District" and "Issuer" shall mean Tarrant Regional Water District, a Water Control and Improvement District.

The term "District's Water System," "Issuer's Water System," or "System" shall mean all of the District's existing water storage, treatment, transportation, distribution, and supply facilities, including all dams, reservoirs, and other properties, wherever located, (a) which are currently being used for water supply purposes and, to the extent financed with the proceeds from the sale of the Bonds or Additional Bonds or moneys from the Contingency Fund (hereinafter created), all facilities acquired or constructed in the future, and all improvements to any of the foregoing, and (b) all other facilities which in the future are deliberately and specifically, at the option of the Board, made a part of the System by resolution of the Board, but such term does not include any oil, gas, and other mineral properties owned by the District or property disposed of from time to time in accordance with the provisions of Section 23(g) hereof, provided that any property acquired in substitution therefor shall be included in the System, along with all repairs to and other replacements of the System. In particular such term includes and shall include (i) all of the District's existing Cedar Creek Project, a dam and reservoir on Cedar Creek in Henderson and Kaufman Counties, Texas, and Eagle Mountain Dam and Reservoir and Bridgeport Dam and Reservoir, which are water supply facilities of the District on the West Fork of the Trinity River, Richland-Chambers Reservoir in Navarro and Freestone Counties, Texas, and all transportation, storage, and other facilities related to all of the foregoing and (ii) the Projects which were, or are to be, financed or refinanced with the proceeds from the sale of bonds originally authorized by the Series 1983 Bond Resolution, the Series 1986 Bond Resolution, Series 1999 Bond Resolution, the Series 2002 Bond Resolution, the Series 2006 Bond Resolution, the Series 2008A Bond Resolution, the Series 2008B Bond Resolution, the Series 2009 Bond Resolution, the Series 2010 Bond Resolution, the Series 2010A Bond Resolution, the Series 2010B Bond Resolution, the Series 2012 Bond Resolution, the Series 2012A Bond Resolution, the Series 2014 Bond Resolution, the Series 2015 Bond Resolution, and this Bond Resolution and made a part of the System. Unless deliberately added to the System by the Board, at its option, in the manner prescribed above, said term does not include any District flood control facilities or facilities which provide waste treatment or other wastewater services of any kind. Said term does not include any facilities acquired or constructed by the District with the proceeds from the issuance of "Special Facilities Bonds," which are hereby defined as being revenue obligations of the District, which are not issued as Additional Bonds, and which are payable from any source, contract, or revenues whatsoever other than the Pledged Revenues; and Special Facilities Bonds may be issued for any lawful purpose and made payable from any source, contract, or revenues whatsoever other than the Pledged Revenues.

The term "Gross Revenues of the System" shall mean all of the revenues, income, rentals, rates, fees, and charges of every nature derived by the Board or the District from the operation and/or ownership of the System (except as hereinafter provided), including specifically all payments and amounts received by the Board or the District from Contracts, and any interest income from the investment of money in any Funds created or maintained pursuant to any resolution authorizing the issuance of Bonds or Additional Bonds, excepting only any Construction Fund created pursuant to any resolution authorizing any Bonds or Additional Bonds. There is excepted from such term, and such term does not include (i) revenues derived by the District from the production of oil, gas, and other minerals owned by the District, or the revenues derived from the granting, sale, or lease of the right to explore for and produce same, or (ii) the royalties, rentals, license fees, and other income (other than from water sales) derived by the District from (a) lands and assets owned by the District as flood control facilities or (b) property of the District at Eagle Mountain Dam and Reservoir and Bridgeport Dam and Reservoir on the West Fork of the Trinity River.

The term "Operating and Maintenance Expenses of the System" or "Current Expenses" shall mean all reasonable and necessary current costs of operation and maintenance of the System including, but not limited to, repairs and replacements, operating personnel, utilities, supervision, engineering, accounting, auditing, legal services, insurance premiums, paying agents fees, and any other supplies and services, administration of the System, and equipment necessary for proper operation and maintenance of the System, as well as payments made for the use or operation of any property, and payments made by the District in satisfaction of judgments or other liabilities resulting from claims not covered by the District's insurance. Neither depreciation nor any other expense which does not represent a cash expenditure shall be considered an item of Operation and Maintenance Expense.

The terms "Net Revenues of the District's Water System", "Net Revenues of the System", and "Net Revenues" shall mean the Gross Revenues of the System less the Operation and Maintenance Expenses of the System.

The term "Pledged Revenues" shall mean: (a) the Net Revenues of the System and (b) any additional revenues, income, receipts, grants, donations, or other resources, received or to be received from any public or private source, whether pursuant to an agreement or otherwise, which in the future may, at the option of the District, be pledged to the payment of the Bonds or the Additional Bonds.

The term "Series 1983 Bond Resolution" shall mean the resolution adopted by the Board of Directors of the District on May 18, 1983, authorizing the Tarrant County Water Control and Improvement District Number One Water Revenue Bonds, Series 1983.

The term "Series 1986 Bond Resolution" shall mean the resolution adopted by the Board of Directors of the District on July 15, 1986, authorizing the Tarrant County Water Control and Improvement District Number One Water Revenue Bonds, Series 1986.

The term "Series 1999 Bond Resolution" shall mean the Resolution adopted by the Board of Directors of the District on May 18, 1999, authorizing Tarrant Regional Water District, a Water Control and Improvement District, Water Revenue Refunding and Improvement Bonds, Series 1999.

The term "Series 2002 Bond Resolution" shall mean the Resolution adopted by the Board of Directors of the District on December 17, 2002, authorizing Tarrant Regional Water District, a Water Control and Improvement District, Water Revenue Refunding and Improvement Bonds, Series 2002.

The term "Series 2006 Bond Resolution" shall mean the Resolution adopted by the Board of Directors of the District on March 21, 2006, authorizing Tarrant Regional Water District, a Water Control and Improvement District, Water Revenue Bonds, Series 2006.

The term "Series 2008A Bond Resolution" shall mean the Resolution adopted by the Board of Directors of the District on June 17, 2008, authorizing Tarrant Regional Water District, a Water Control and Improvement District, Water Revenue Bonds, Series 2008A.

The term "Series 2008A Bonds" shall mean all unpaid and unrefunded Series 2008A Bonds authorized by the Series 2008A Bond Resolution.

The term "Series 2008B Bond Resolution" shall mean the Resolution adopted by the Board of Directors of the District on June 17, 2008, authorizing Tarrant Regional Water District, a Water Control and Improvement District, Water Revenue Bonds, Series 2008B.

The term "Series 2008B Bonds" shall mean all unpaid and unrefunded Series 2008B Bonds authorized by the Series 2008B Bond Resolution.

The term "Series 2009 Bond Resolution" shall mean the Resolution adopted by the Board of Directors of the District on January 20, 2009, authorizing Tarrant Regional Water District, a Water Control and Improvement District, Water Revenue Refunding and Improvement Bonds, Series 2009.

The term "Series 2009 Bonds" shall mean all unpaid and unrefunded Series 2009 Bonds authorized by the Series 2009 Bond Resolution.

The term "Series 2010 Bond Resolution" shall mean the Resolution adopted by the Board of Directors of the District on January 19, 2010, authorizing Tarrant Regional Water District, a Water Control and Improvement District, Water Revenue Bonds, Series 2010.

The term "Series 2010 Bonds" shall mean all unpaid and unrefunded Series 2010 Bonds authorized by the Series 2010 Bond Resolution.

The term "Series 2010A Bond Resolution" shall mean the Resolution adopted by the Board of Directors of the District on May 18, 2010, authorizing Tarrant Regional Water District, a Water Control and Improvement District, Water Revenue Bonds, Series 2010A.

The term "Series 2010A Bonds" shall mean all unpaid and unrefunded Series 2010A Bonds authorized by the Series 2010A Bond Resolution.

The term "Series 2010B Bond Resolution" shall mean the Resolution adopted by the Board of Directors of the District on May 18, 2010, authorizing Tarrant Regional Water District, a Water Control and Improvement District, Water Revenue Bonds, Series 2010B.

The term "Series 2010B Bonds" shall mean all unpaid and unrefunded Series 2010B Bonds authorized by the Series 2010B Bond Resolution.

The term "Series 2012 Bond Resolution" shall mean the Resolution adopted by the Board of Directors of the District on January 17, 2012, authorizing Tarrant Regional Water District, a Water Control and Improvement District, Water Revenue Refunding and Improvement Bonds, Series 2012.

The term "Series 2012 Bonds" shall mean all unpaid and unrefunded Series 2012 Bonds authorized by the Series 2012 Bond Resolution.

The term "Series 2012A Bond Resolution" shall mean the Resolution adopted by the Board of Directors of the District on September 18, 2012, authorizing Tarrant Regional Water District, a Water Control and Improvement District, Water Revenue Refunding Bonds, Series 2012A.

The term "Series 2012A Bonds" shall mean all unpaid and unrefunded Series 2012A Bonds authorized by the Series 2012A Bond Resolution

The term "Series 2014 Bond Resolution" shall mean the Resolution adopted by the Board of Directors of the District on January 21, 2014, authorizing Tarrant Regional Water District, a Water Control and Improvement District, Water Revenue Bonds, Series 2014.

The term "Series 2014 Bonds" shall mean all unpaid and unrefunded Series 2014 Bonds authorized by the Series 2014 Bond Resolution

The term "Series 2015 Bond Resolution" shall mean the Resolution adopted by the Board of Directors of the District on January 20, 2015, authorizing Tarrant Regional Water District, a Water Control and Improvement District, Water Revenue Refunding Bonds, Series 2015.

The term "Series 2015 Bonds" shall mean all unpaid and unrefunded Series 2015 Bonds authorized by the Series 2015 Bond Resolution.

The term "Series 2015A Bonds" shall mean collectively the Initial Bond as described and defined in Sections 1, 2, and 3 of this Bond Resolution, and all substitute bonds exchanged therefor, as well as all other substitute bonds and replacement bonds issued pursuant to this Bond Resolution, all as provided for herein; and the Series 2015A Bonds are Additional Bonds issued to be payable from and secured by a first lien on and pledge of the Pledged Revenues equally and ratably on a parity with all of the other Bonds, Sections 21 and 22 of the Series 2008A Bond Resolution, the Series 2008B Bond Resolution, the Series 2009 Bond Resolution, the Series 2010 Bond Resolution, the Series 2010A Bond Resolution, the Series 2010B Bond Resolution, the Series 2012 Bond Resolution, the Series 2012A Bond Resolution, the Series 2014 Bond Resolution, and the Series 2015 Bond Resolution.

The term "TWDB" shall mean the Texas Water Development Board.

The terms "year" and "fiscal year" shall mean the District's fiscal year, which currently ends on September 30, but which subsequently may be any other 12 month period hereafter established by the District as a fiscal year for the purposes of the System and any resolution authorizing the Bonds or any Additional Bonds.

Section 9. PLEDGE. (a) That the Bonds, as defined above, and any Additional Bonds, and the interest thereon, are and shall be secured equally and ratably on a parity by and payable from a first lien on and pledge of the Pledged Revenues; and the Series 2015A Bonds are Additional Bonds payable from and secured by a first lien on and pledge of the Pledged Revenues, as permitted by Sections 21 and 22 of the Series 2008A Bond Resolution, Series 2008B Bond Resolution, Series 2009 Bond Resolution, Series 2010 Bond Resolution, Series 2010A Bond Resolution, Series 2010B

Bond Resolution, the Series 2012 Bond Resolution, the Series 2012A Bond Resolution, the Series 2014 Bond Resolution, and the Series 2015 Bond Resolution.

(b) That Chapter 1208, Government Code, applies to the issuance of the Bonds and the pledge of the revenues granted by the Issuer under this Section, and is therefore valid, effective, and perfected. Should Texas law be amended at any time while the Bonds are outstanding and unpaid, the result of such amendment being that the pledge of the revenues granted by the Issuer under this Section is to be subject to the filing requirements of Chapter 9, Business & Commerce Code, in order to preserve to the registered owners of the Bonds a security interest in said pledge, the Issuer agrees to take such measures as it determines are reasonable and necessary under Texas law to comply with the applicable provisions of Chapter 9, Business & Commerce Code and enable a filing of a security interest in said pledge to occur.

Section 10. REVENUE FUND. That there has been created and established, and there shall be maintained on the books of the District, and accounted for separate and apart from all other funds of the District, a special fund to be entitled the "Tarrant Regional Water District Water Revenue Bonds Revenue Fund" (hereinafter called the "Revenue Fund"). All Gross Revenues of the System (except investment interest and income from the other Funds hereinafter described and maintained) shall be credited to the Revenue Fund immediately upon receipt. All Operation and Maintenance Expenses of the System shall be paid from such Gross Revenues credited to the Revenue Fund, as a first charge against same.

Section 11. INTEREST AND REDEMPTION FUND. That for the sole purpose of paying the principal of and interest on all Bonds and any Additional Bonds, as the same come due, either upon redemption or at maturity, there has been created and established, and there shall be maintained, at an official depository bank of the District, a separate fund to be entitled the "Tarrant Regional Water District Revenue Bonds Interest and Redemption Fund" (hereinafter called the "Interest and Redemption Fund").

Section 12. THE CONTINGENCY AND IMPROVEMENT FUND AND THE RESERVE FUND. (a) That there has been created and established and there shall be maintained, at an official depository bank of the District, a separate fund to be entitled the "Tarrant Regional Water District Water Revenue Bonds Contingency and Improvement Fund" (hereinafter called the "Contingency Fund"). The Contingency Fund shall be used solely for the purpose of paying the costs of improvements, enlargements, extensions, additions, or other capital expenditures relating to the System, and unexpected or extraordinary replacements of the System, for which System funds are not otherwise available, or for paying unexpected or extraordinary Operation and Maintenance Expenses of the System for which System Funds are not otherwise available, or for paying principal of and interest on any Bonds or Additional Bonds, when and to the extent the amount in the Interest and Redemption Fund is insufficient for such purpose.

(b) That there has been created and established and there shall be maintained at an official depository bank of the District, a separate fund to be entitled the "Tarrant Regional Water District Water Revenue Bonds Reserve Fund" (hereinafter called the "Reserve Fund"), solely for the further security and benefit of the Bonds and any Additional Bonds. The Reserve Fund shall be used solely for the purpose of (i) finally retiring the last of the Bonds and any Additional Bonds, and (ii)

paying principal of and interest on the Bonds or any Additional Bonds when and to the extent the amounts in the Interest and Redemption Fund and Contingency Fund are insufficient for such purpose. Out of proceeds of the Bonds, there shall be deposited to the Reserve Fund an amount of money, if any, sufficient to cause the Reserve Fund to contain the Required Amount (hereinafter defined). When and so long as the money and investments in the Reserve Fund are not less in market value than a "Required Amount" equal to the principal and interest requirements of the Bonds during the fiscal year in which such requirements are scheduled to be the greatest, no deposits shall be made to the credit of the Reserve Fund; but when and if the Reserve Fund at any time thereafter contains less than said "Required Amount" in market value, then, subject and subordinate to making the required deposits to the credit of the Interest and Redemption Fund, the District shall transfer from Pledged Revenues and deposit to the credit of the Reserve Fund, semiannually on or before the 25th days of each February and each August of each year, a sum equal to 1/10th of the "Required Amount" until the Reserve Fund is restored to said "Required Amount." So long as the Reserve Fund contains said "Required Amount" in market value, all amounts in excess of said "Required Amount," if any, shall, at least annually, on or before the 25th day of February of each year, be deposited to the credit of the Interest and Redemption Fund.

Section 13. DEPOSITS OF PLEDGED REVENUES; INVESTMENTS. (a) That the Pledged Revenues shall be deposited into the Interest and Redemption Fund, the Reserve Fund, and the Contingency Fund, when and as required by this Bond Resolution, Sections 8 through 24 of which are cumulative of and supplemental to Sections 8 through 24 of the Series 2008A Bond Resolution, the Series 2008B Bond Resolution, the Series 2009 Bond Resolution, the Series 2010 Bond Resolution, the Series 2010A Bond Resolution, the Series 2010B Bond Resolution, the Series 2012 Bond Resolution, the Series 2012A Bond Resolution, the Series 2014 Bond Resolution, and the Series 2015 Bond Resolution, and Sections 8 through 24 of this Bond Resolution shall be applicable to all of the Bonds.

(b) That money in any Fund maintained pursuant to this Bond Resolution may, at the option of the District, be placed in time deposits or certificates of deposit secured by obligations of the type hereinafter described, or be invested in direct obligations of the United States of America, obligations guaranteed or insured by the United States of America, which, in the opinion of the Attorney General of the United States, are backed by its full faith and credit or represent its general obligations, or invested in indirect obligations of the United States of America, including, but not limited to, evidences of indebtedness issued, insured, or guaranteed by such governmental agencies as the Federal Land Banks, Federal Intermediate Credit Banks, Banks for Cooperatives, Federal Home Loan Banks, Government National Mortgage Association, United States Postal Service, Farmers Home Administration, Federal Home Loan Mortgage Association, Small Business Administration, Federal Housing Association, or Participation Certificates in the Federal Assets Financing Trust; provided that all such deposits and investments shall be made in such manner that the money required to be expended from any Fund will be available at the proper time or times. Such investments shall be valued by the District in terms of current market value as of the 20th day of February of each year. All interest and income derived from such deposits and investments immediately shall be credited to, and any losses debited to, the Fund from which the deposit or investment was made, and surpluses in any Fund shall be disposed of as herein provided. Such investments shall be sold promptly when necessary to prevent any default in connection with the Bonds or Additional Bonds.

Section 14. FUNDS SECURED. That money in all Funds described in this Bond Resolution shall be secured in the manner prescribed by law for securing funds of the District.

Section 15. DEBT SERVICE REQUIREMENTS. (a) That promptly after the delivery of the Initial Bond the District shall cause to be deposited to the credit of the Interest and Redemption Fund all accrued interest, if any, received from the sale and delivery of the Initial Bond, and any such deposit shall be used to pay part of the interest coming due on the Series 2015A Bonds.

(b) That the District shall transfer from the Pledged Revenues and deposit to the credit of the Interest and Redemption Fund the amounts, at the times, as follows:

(1) such amounts, deposited semiannually on or before the 25th day of each February and each August of each year, as will be sufficient, together with other amounts, if any, then on hand in the Interest and Redemption Fund and available for such purpose, to pay the interest scheduled to accrue and come due on all Bonds on the next succeeding interest payment date; and

(2) such amounts, deposited annually, on or before the 25th day of each February, as will be sufficient, together with other amounts, if any, then on hand in the Interest and Redemption Fund and available for such purpose, to pay all principal scheduled to mature and come due on all Bonds on the next succeeding March 1, and to pay all principal of all Bonds, if any, scheduled to be redeemed prior to maturity on the next succeeding March 1 in accordance with the mandatory redemption provisions and schedules set forth in any applicable Bond Resolution.

Section 16. CONTINGENCY REQUIREMENTS. That there is now on deposit to the credit of the Contingency Fund an amount equal to at least $1,100,000. No additional deposits are required to be made to the credit of the Contingency Fund unless and until such amount therein is reduced or depleted. If and when such amount in the Contingency Fund is reduced or depleted then, subject and subordinate to making the required deposits to the credit of the Interest and Redemption Fund and the Reserve Fund, such reduction or depletion shall be restored from amounts which shall be provided for such purpose in the District's Annual Budget for the next ensuing fiscal year or years; provided that the District is not required to budget more than $100,000 for such purpose during any one fiscal year; but the District shall have the right to budget additional amounts for such purpose if it is deemed necessary or advisable by the Board. So long as the Contingency Fund contains money and investments not less than the amount of $1,100,000 in market value, any surplus in the Contingency Fund over said amount shall, semiannually on or before February 15 and August 15 of each year, be withdrawn, deposited to the credit of the Revenue Fund, commingled with other revenues from the operation of the System, and used for any lawful purpose for which Gross Revenues of the System may be used.

Section 17. DEFICIENCIES; EXCESS PLEDGED REVENUES. (a) That if on any occasion there shall not be sufficient Pledged Revenues to make the required deposits into the Interest and Redemption Fund, the Reserve Fund, and the Contingency Fund, then such deficiency shall be made up as soon as possible from the next available Pledged Revenues, or from any other sources available for such purpose.

(b) That, subject to making the required deposits to the credit of the Interest and Redemption Fund, the Reserve Fund, and the Contingency Fund, when and as required by this Bond Resolution, or any resolution authorizing the issuance of Additional Bonds, the excess Pledged Revenues may be used for any lawful purpose.

Section 18. BONDS AND ADDITIONAL BONDS NOT PAYABLE FROM TAXES. It is specifically provided that the District is not authorized to, and shall not, levy, collect, or use any tax of any nature to pay the principal of or interest on any of the Bonds or Additional Bonds.

Section 19. PAYMENT OF BONDS AND ADDITIONAL BONDS. Semiannually on or before each March 1 and September 1 while any of the Bonds or Additional Bonds are outstanding and unpaid, the District shall make available to the paying agents therefor, ratably and on a parity out of the Interest and Redemption Fund, and/or the Contingency Fund, or, from the Reserve Fund, money sufficient to pay such interest on and such principal of the Bonds or Additional Bonds as will accrue or mature, or which is scheduled to be redeemed prior to maturity, on each such March 1 and September 1, respectively. The paying agents shall destroy all paid Bonds or Additional Bonds, and the coupons, if any, appertaining thereto, and furnish the District with an appropriate certificate of cancellation or destruction.

Section 20. DEFEASANCE OF BONDS. (a) Any Bond and the interest thereon shall be deemed to be paid, retired, and no longer outstanding (a "Defeased Bond") within the meaning of this Resolution, except to the extent provided in subsection (d) of this Section, when payment of the principal of such Bond, plus interest thereon to the due date (whether such due date be by reason of maturity, or otherwise) either (i) shall have been made or caused to be made in accordance with the terms thereof or (ii) shall have been provided for on or before such due date by irrevocably depositing with or making available to the Paying Agent/Registrar in accordance with an escrow agreement or other instrument (the "Future Escrow Agreement") for such payment (1) lawful money of the United States of America sufficient to make such payment or (2) Defeasance Securities that mature as to principal and interest in such amounts and at such times as will insure the availability, without reinvestment, of sufficient money to provide for such payment, and when proper arrangements have been made by the Issuer with the Paying Agent/Registrar for the payment of its services until all Defeased Bonds shall have become due and payable. At such time as a Bond shall be deemed to be a Defeased Bond hereunder, as aforesaid, such Bond and the interest thereon shall no longer be secured by, payable from, or entitled to the benefits of, the revenues herein pledged as provided in this Resolution, and such principal and interest shall be payable solely from such money or Defeasance Securities. Notwithstanding any other provision of this Resolution to the contrary, it is hereby provided that any determination not to redeem Defeased Bonds that is made in conjunction with the payment arrangements specified in subsection 20(a)(i) or (ii) shall not be irrevocable, provided that: (1) in the proceedings providing for such payment arrangements, the Issuer expressly reserves the right to call the Defeased Bonds for redemption; (2) the Issuer gives notice of the reservation of that right to the owners of the Defeased Bonds immediately following the making of the payment arrangements, and (3) the Issuer directs that notice of the reservation be included in any redemption notices that it authorizes.

(b) Any moneys so deposited with the Paying Agent/Registrar may at the written direction of the Issuer also be invested in Defeasance Securities, maturing in the amounts and times as hereinbefore set forth, and all income from such Defeasance Securities received by the Paying Agent/Registrar that is not required for the payment of the Bonds and interest thereon, with respect to which such money has been so deposited, shall be turned over to the Issuer, or deposited as directed in writing by the Issuer. Any Future Escrow Agreement pursuant to which the money and/or Defeasance Securities are held for the payment of Defeased Bonds may contain provisions permitting the investment or reinvestment of such moneys in Defeasance Securities or the substitution of other Defeasance Securities upon the satisfaction of the requirements specified in subsection 20(a)(i) or (ii). All income from such Defeasance Securities received by the Paying Agent/Registrar which is not required for the payment of the Defeased Bonds, with respect to which such money has been so deposited, shall be remitted to the Issuer or deposited as directed in writing by the Issuer.

(c) The term "Defeasance Securities" means (i) direct, noncallable obligations of the United States of America, including obligations that are unconditionally guaranteed by the United States of America, (ii) noncallable obligations of an agency or instrumentality of the United States of America, including obligations that are unconditionally guaranteed or insured by the agency or instrumentality and that, on the date of the purchase thereof are rated as to investment quality by a nationally recognized investment rating firm not less than AAA or its equivalent, and (iii) noncallable obligations of a state or an agency or a county, municipality, or other political subdivision of a state that have been refunded and that, on the date the governing body of the Issuer adopts or approves the proceedings authorizing the financial arrangements are rated as to investment quality by a nationally recognized investment rating firm not less than AAA or its equivalent.

(d) Until all Defeased Bonds shall have become due and payable, the Paying Agent/Registrar shall perform the services of Paying Agent/Registrar for such Defeased Bonds the same as if they had not been defeased, and the Issuer shall make proper arrangements to provide and pay for such services as required by this Resolution.

(e) In the event that the Issuer elects to defease less than all of the principal amount of Bonds of a maturity, the Paying Agent/Registrar shall select, or cause to be selected, such amount of Bonds by such random method as it deems fair and appropriate.

Section 21. ADDITIONAL BONDS. (a) That the District shall have the right and power at any time and from time to time, and in one or more Series or issues, to authorize, issue, and deliver additional bonds (herein called "Additional Bonds"), which may be payable from and secured by a first lien on and pledge of the Pledged Revenues. No Additional Bonds shall be payable from or secured by ad valorem or other taxes.

(b) Additional Bonds, if and when authorized, issued, and delivered in accordance with the provisions hereof, shall be payable from the Interest and Redemption Fund, and shall be payable from and secured by a first lien on and pledge of the Pledged Revenues, equally and ratably on a parity with the Bonds and all other outstanding Additional Bonds.

(c) That the principal of all Additional Bonds must be scheduled to be paid or mature on March 1 of the years in which such principal is scheduled to be paid or mature; and all interest thereon must be payable on March 1 and September 1.

Section 22. FURTHER REQUIREMENTS FOR ADDITIONAL BONDS. (a) That Additional Bonds shall be issued only in accordance with the provisions hereof, and then applicable laws, and may be issued in any amounts, for any lawful purpose relating to the System, including the refunding of any Bonds or Additional Bonds. No installment, Series, or issue of Additional Bonds shall be issued or delivered unless the President and the Secretary of the Board sign a written certificate to the effect (i) that the District is not in default as to any covenant, condition, or obligation in connection with all outstanding Bonds and Additional Bonds, and the resolutions authorizing the same, (ii) that the Interest and Redemption Fund and the Reserve Fund contain the amount then required to be therein, and (iii) that either (1) the Pledged Revenues in each fiscal year, commencing (A) with the third complete fiscal year following the execution of such certificate or report, or (B) with the fiscal year following the estimated completion date of any project for which the then proposed Additional Bonds are being issued (whichever of (A) or (B) is later) are estimated, based on a report of an independent engineer or firm of engineers, to be at least equal to 1.25 times the average annual principal and interest requirements of all Bonds and Additional Bonds to be outstanding after delivery of the then proposed Additional Bonds, or (2) based upon an opinion of legal counsel to the District, there are Contracts then in effect pursuant to which parties to such Contracts are obligated to make minimum payments to the District on a "take or pay" basis at such times and in such amounts as shall be necessary to provide to the District Pledged Revenues sufficient to pay when due all principal of and interest on all Bonds and Additional Bonds.

(b) That each resolution authorizing the issuance of Additional Bonds shall confirm the Reserve Fund as additional security for all such Additional Bonds, and the Reserve Fund shall be increased to the extent required to cause the Reserve Fund to be maintained in an amount not less than the principal and interest requirements, during the fiscal year in which such requirements are scheduled to be the greatest, of all Bonds and Additional Bonds to be outstanding after the issuance of such then proposed Additional Bonds (or any greater amount as may, at the option of the District, be provided for in any resolution authorizing the issuance of any Additional Bonds), and shall make provision for funding such Reserve Fund from Pledged Revenues, or, at the option of the District, from bond proceeds or other available sources. Such Reserve Fund may be funded in whole or in part initially, or may be funded in whole or in part from Pledged Revenues by approximately equal periodic payments, not less than annual, and within not more than five years from the date of such then proposed Additional Bonds.

(c) That all calculations of principal and interest requirements of any bonds made in connection with the issuance of any then proposed Additional Bonds shall be made as of the date of such Additional Bonds; and also in making calculations for such purpose, or for any other purpose under any resolution authorizing any Bonds or Additional Bonds, the principal amounts of any Bonds or Additional Bonds which must be redeemed prior to maturity pursuant to any applicable mandatory redemption requirements shall be deemed to be maturing amounts of principal.

Section 23. GENERAL COVENANTS, REPRESENTATIONS, AND WARRANTIES. That the District further covenants, represents, warrants, and agrees that:

(a) PERFORMANCE. It will faithfully perform at all times any and all covenants, undertakings, stipulations, and provisions contained in each resolution authorizing the issuance of the Bonds and any Additional Bonds, and in each and every Bond and Additional Bond; that it will promptly pay or cause to be paid the principal of and interest on every Bond and Additional Bond, on the dates and in the places and manner prescribed in such resolutions and Bonds or Additional Bonds, and that it will, at the times and in the manner prescribed, deposit or cause to be deposited the amounts required to be deposited into the Interest and Redemption Fund; and any holder of the Bonds or Additional Bonds may require the District, its Board, and its officials and employees, to carry out, respect, or enforce the covenants and obligations of each resolution authorizing the issuance of the Bonds and any Additional Bonds, by all legal and equitable means, including specifically, but without limitation, the use and filing of mandamus proceedings, in any court of competent jurisdiction, against the District, its Board, and its officials and employees.

(b) DISTRICT'S LEGAL AUTHORITY. It is a duly created and existing conservation and reclamation district of the State of Texas pursuant to Article 16, Section 59, of the Texas Constitution, and the laws of the State of Texas, and is duly authorized under the laws of the State of Texas to create and issue the Bonds; that all action on its part for the creation and issuance of the Bonds has been duly and effectively taken, and that the Bonds in the hands of the holders and owners thereof are and will be valid and enforceable obligations of the District in accordance with their terms.

(c) TITLE. It has acquired and constructed, and will operate and maintain the System, and has or will obtain lawful title to, or the lawful right to use and operate, the lands, buildings, and facilities constituting the System, that it warrants that it will defend the title to or lawful right to use and operate, all of the aforesaid lands, buildings, and facilities, and every part thereof, for the benefit of the holders and owners of the Bonds and Additional Bonds against the claims and demands of all persons whomsoever, and is lawfully qualified to pledge the Pledged Revenues to the payment of the Bonds and Additional Bonds in the manner prescribed herein, and has lawfully exercised such rights.

(d) LIENS. It will from time to time and before the same become delinquent pay and discharge all taxes, assessments, and governmental charges, if any, which shall be lawfully imposed upon it, or the System, that it will pay all lawful claims for rents, royalties, labor, materials, and supplies which if unpaid might by law become a lien or charge thereon, the lien of which would be prior to or interfere with the liens hereof, so that the priority of the liens granted hereunder shall be fully preserved in the manner provided herein, and that it will not create or suffer to be created any mechanic's, laborer's, materialman's, or other lien or charge which might or could be prior to the liens hereof, or do or suffer any matter or thing whereby the liens hereof might or could be impaired; provided, however, that no such tax, assessment, or charge, and that no such claims which might be used as the basis of a mechanic's, laborer's, materialman's, or other lien or charge, shall be required to be paid so long as the validity of the same shall be contested in good faith by the District.

(e) OPERATION OF THE SYSTEM. While the Bonds or any Additional Bonds are outstanding and unpaid it will cause the System to be continuously and efficiently operated and maintained in good condition, repair, and working order, and at a reasonable cost.

(f) FURTHER ENCUMBRANCE. While the Bonds or any Additional Bonds are outstanding and unpaid, it will not additionally encumber the Pledged Revenues in any manner, except as permitted hereby in connection with Additional Bonds, unless said encumbrance is made junior and subordinate in all respects to the liens, pledges, covenants, and agreements of each resolution authorizing the issuance of the Bonds and any Additional Bonds; but the right of the District and the Board to issue revenue bonds for any lawful purpose payable from a subordinate lien on the Pledged Revenues is specifically recognized and retained. This Resolution does not and is not intended to affect, limit, or prohibit the issuance of bonds payable solely from ad valorem taxes.

(g) SALE OF PROPERTY. While the Bonds or any Additional Bonds, are outstanding and unpaid, it will maintain its current legal corporate status as a conservation and reclamation district, and it will not sell, convey, mortgage, or in any manner transfer title to, or lease or otherwise dispose of the entire System, or any significant or substantial part thereof; provided that whenever the District deems it necessary to dispose of any real or personal property, machinery, fixtures, or equipment, it may sell or otherwise dispose of such real or personal property, machinery, fixtures, or equipment when it has made arrangements to replace the same or provide substitutes therefor, unless it is determined by resolution of the Board that no such replacement or substitute is necessary; and all proceeds from the sale thereof shall be credited to the Revenue Fund. In all events counsel to the Issuer shall opine as to the validity of the Resolution, as supplemented and amended and counsel to the Contracting Parties shall opine on the validity of the obligation of the Contracting Parties under the Contract.

(h) INSURANCE. (1) It will carry or cause to be carried such insurance as usually would be carried by corporations or other business entities operating like properties and engaged in similar activities, with a responsible insurance company or companies; provided that no insurance shall be required to the extent that the Board determines, based on the advise of legal counsel, that no substantial liability can or will arise under a particular hazard. At any time while any contractor engaged in construction work shall be fully responsible therefor, the District shall not be required to carry insurance on the works being constructed, if the contractor is required to carry appropriate insurance. All such policies shall be open to the inspection of the owners or holders of the Bonds and Additional Bonds and their representatives at all reasonable times.

(2) Upon the happening of any loss or damage covered by insurance from one or more of said causes, the District shall make due proof of loss and shall do all things necessary or desirable to cause the insuring companies to make payment in full directly to the District. The proceeds of insurance covering such property, together with any other funds necessary and available for such purpose, shall be used forthwith by the District for repairing the property damaged or replacing the property destroyed; provided, however, that if said insurance proceeds and other funds are insufficient for such purpose, then said insurance proceeds pertaining to the System shall be used promptly as follows:

(a) for the redemption prior to maturity of the Bonds and Additional Bonds, if any, ratably in the proportion that the outstanding principal of each Series or issue of Bonds or Additional Bonds bears to the total outstanding principal of all Bonds and Additional Bonds; provided that if on any such occasion the principal of any such Series or issue is not

subject to redemption, it shall not be regarded as outstanding in making the foregoing computation; or

(b) if none of the outstanding Bonds or Additional Bonds is subject to redemption, then for the purchase on the open market and retirement of said Bonds and Additional Bonds, in the same proportion as prescribed in the foregoing clause (a), to the extent practicable; provided that the purchase price for any such Bond or Additional Bonds shall not exceed the redemption price of such Bond or Additional Bond on the first date upon which it becomes subject to redemption; or

(c) to the extent that the foregoing clauses (a) and (b) cannot be complied with at the time, the insurance proceeds, or the remainder thereof, shall be deposited in a special and separate trust fund, at an official depository of the District, to be designated the Insurance Account. The Insurance Account shall be held until such time as the foregoing clauses (a) and/or (b) can be complied with, or until other funds become available which, together with the Insurance Account, will be sufficient to make the repairs or replacements originally required, whichever of said events occurs first.

(3) The annual audit hereinafter required shall contain a list of all such insurance policies carried, together with a statement as to whether or not all insurance premiums upon such policies have been paid.

(i) RATE COVENANT. It will fix, establish, maintain, revise (if and when necessary), and collect such rates, charges, and fees for the sale of water from the System and for the use and availability of the System as are necessary to produce Gross Revenues of the System sufficient, together with any other Pledged Revenues and any taxes as may be levied by the District for such purpose, (1) to pay all Operation and Maintenance Expenses of the System, and (2) to produce Pledged Revenues adequate to provide for all payments and deposits required to be made into the Interest and Redemption Fund, the Reserve Fund, and the Contingency Fund, when and as required by the resolutions authorizing all Bonds and Additional Bonds.

(j) RECORDS. It will keep proper books of records and accounts in which full, true, and correct entries will be made of all dealings, activities, and transactions relating to the System, the Pledged Revenues, and all Funds created pursuant to each resolution authorizing the issuance of the Bonds and Additional Bonds; and all books, documents, and vouchers relating thereto shall at all reasonable times be made available for inspection upon request of any bondholder.

(k) AUDITS. Each year while any of the Bonds or Additional Bonds are outstanding, an audit will be made of its books and accounts relating to the System and the Pledged Revenues by an independent certified public accountant or an independent firm of certified public accountants. As soon as practicable after the close of each year, and when said audit has been completed and made available to the District, a copy of such audit for the preceding year shall be mailed to the Municipal Advisory Council of Texas and to any bondholders who shall so request in writing. Such annual audit reports shall be open to the inspection of the owners or holders of the Bonds and Additional Bonds and their agents and representatives at all reasonable times.

(1) GOVERNMENTAL AGENCIES. It will comply with all of the terms and conditions of any and all franchises, permits, and agreements applicable to the System and the Bonds or Additional Bonds entered into between the District and any governmental agency, and the District will take all action necessary to enforce said terms and conditions; and the District will obtain and keep in full force and effect all franchises, permits, and other requirements necessary with respect to the acquisition, construction, operation, and maintenance of the System.

(m) CONTRACTS. It will comply with the terms and conditions of the Contracts and will cause the other parties to the Contracts to comply with all of their obligations thereunder by all lawful means; and the Contracts will not be rescinded, modified, or amended in any way which would have a materially adverse effect on the operation of the System or the rights of the owners of the Bonds and Additional Bonds.

(n) ANNUAL BUDGET. On or before August 1 of each calendar year, it will prepare the preliminary Annual Budget of Operation and Maintenance Expenses of the System for the ensuing fiscal year, and such budget shall include a showing as to the proposed expenditures for such ensuing fiscal year, and shall show the estimated amount of Net Revenues of the System for such year. If the owners or holders of 25% in aggregate principal amount of the Bonds and Additional Bonds then outstanding shall so request on or before the 15th day of the aforesaid month, the Board shall hold a public hearing on or before the 15th day of the following month, at which any bondholder may appear in person or by agent or attorney and present any objections he may have to the final adoption of such budget. Notice of the time and place of such hearing shall be published twice, once in each of two successive weeks, in a newspaper of general circulation published in the District, with the date of the first publication to be at least fourteen days before the date fixed for the hearing; and copies of such notice shall be mailed at least ten days before the hearing to each bondholder who shall have filed his name and address with the Secretary of the Board for such purpose. The District further covenants that on or before October 1 of each calendar year it will finally adopt the Annual Budget of Operation and Maintenance Expenses of the System for such fiscal year (hereinafter sometimes called the "Annual Budget"). If for any reason the Board shall not have adopted the Annual Budget before the first day of any fiscal year, the budget for the preceding fiscal year shall be deemed to be in force until the adoption of the Annual Budget. The Operation and Maintenance Expenses of the System incurred in any fiscal year will not exceed the reasonable and necessary amount thereof. The District may, at any time deemed necessary by the Board, adopt an Amended or Supplemental Budget for the remainder of the then current fiscal year.

Section 24. AMENDMENT OF RESOLUTION. (a) The holders and registered owners of Bonds and Additional Bonds (hereinafter collectively called "holders") aggregating 51% in principal amount of the aggregate principal amount of then outstanding Bonds and Additional Bonds shall have the right from time to time to approve any amendment to any resolution authorizing the issuance of any Bonds or Additional Bonds, which may be deemed necessary or desirable by the District, provided, however, that nothing herein contained shall permit or be construed to permit the amendment of the terms and conditions in said resolutions or in the Bonds or Additional Bonds so as to:

(1) Make any change in the maturity of the outstanding Bonds or Additional Bonds;

(2) Reduce the rate of interest borne by any of the outstanding Bonds or Additional Bonds;

(3) Reduce the amount of the principal payable on the outstanding Bonds or Additional Bonds;

(4) Modify the terms of payment of principal of or interest on the outstanding Bonds or Additional Bonds, or impose any conditions with respect to such payment;

(5) Effect any change in the rights of the holders of the Bonds and Additional Bonds then outstanding, other than a change which similarly affects all such holders;

(6) Change the minimum percentage of the principal amount of Bonds and Additional Bonds necessary for consent to such amendment.

(b) If at any time the District shall desire to amend a resolution under this Section, the District shall cause notice of the proposed amendment to be published in a financial newspaper or journal published in The City of New York, New York, once during each calendar week for at least two successive calendar weeks. Such notice shall briefly set forth the nature of the proposed amendment and shall state that a copy thereof is on file at the principal office of each Paying Agent/Registrar for the Bonds and Additional Bonds, for inspection by all holders of Bonds and Additional Bonds. Such publication is not required, however, if notice in writing is given to each holder of Bonds and Additional Bonds.

(c) Whenever at any time not less than thirty days, and within one year, from the date of the first publication of said notice or other service of written notice the District shall receive an instrument or instruments executed by the holders of at least 51% in aggregate principal amount of all Bonds and Additional Bonds then outstanding, which instrument or instruments shall refer to the proposed amendment described in said notice and which specifically consent to and approve such amendment in substantially the form of the copy thereof on file as aforesaid, the District may adopt the amendatory resolution in substantially the same form.

(d) Upon the adoption of any amendatory resolution pursuant to the provisions of this Section, the resolution being amended shall be deemed to be amended in accordance with the amendatory resolution, and the respective rights, duties, and obligations of the District and all the holders of then outstanding Bonds and Additional Bonds and all future Additional Bonds shall thereafter be determined, exercised, and enforced hereunder, subject in all respects to such amendment.

(e) Any consent given by the holder of a Bond or Additional Bonds pursuant to the provisions of this Section shall be irrevocable for a period of six months from the date of the first publication of the notice provided for in this Section, and shall be conclusive and binding upon all future holders of the same Bond or Additional Bond during such period. Such consent may be revoked at any time after six months from the date of the first publication of such notice by the holder who gave such consent, or by a successor in title, by filing notice thereof with each Paying Agent/Registrar for the Bonds and Additional Bonds, and the District, but such revocation shall not be effective if the holders of 51% in aggregate principal amount of the then outstanding Bonds and

Additional Bonds as in this Section defined have, prior to the attempted revocation, consented to and approved the amendment.

(f) For the purpose of this Section, the fact of the holding of Bonds or Additional Bonds by any holder of Bonds or Additional Bonds which are not registered and which are payable to bearer, and the amount and numbers of such registered Bonds and Additional Bonds, and the date of their holding same, may be provided by the affidavit of the person claiming to be such holder, or by a certificate executed by any trust company, bank, banker, or any other depository wherever situated showing that at the date therein mentioned such person had on deposit with such trust company, bank, banker, or other depository, the Bonds or Additional Bonds described in such certificate. The District may conclusively assume that such ownership continues until written notice to the contrary is served upon the District. All matters relating to the ownership of registered Bonds and Additional Bonds shall be determined from the bond registration books kept by the registrar therefor.

Section 25. DAMAGED, MUTILATED, LOST, STOLEN, OR DESTROYED SERIES 2015A BONDS. (a) Replacement Bonds. In the event any outstanding Series 2015A Bond is damaged, mutilated, lost, stolen, or destroyed, the Paying Agent/Registrar shall cause to be printed, executed, and delivered, a new bond of the same principal amount, maturity, and interest rate, as the damaged, mutilated, lost, stolen, or destroyed Bond, in replacement for such Series 2015A Bond in the manner hereinafter provided.

(b) Application for Replacement Bonds. Application for replacement of damaged, mutilated, lost, stolen, or destroyed Series 2015A Bonds shall be made by the registered owner thereof to the Paying Agent/Registrar. In every case of loss, theft, or destruction of a Series 2015A Bond, the registered owner applying for a replacement bond shall furnish to the Issuer and to the Paying Agent/Registrar such security or indemnity as may be required by them to save each of them harmless from any loss or damage with respect thereto. Also, in every case of loss, theft, or destruction of a Series 2015A Bond, the registered owner shall furnish to the Issuer and to the Paying Agent/Registrar evidence to their satisfaction of the loss, theft, or destruction of such Series 2015A Bond, as the case may be. In every case of damage or mutilation of a Series 2015A Bond, the registered owner shall surrender to the Paying Agent/Registrar for cancellation the Series 2015A Bond so damaged or mutilated.

(c) No Default Occurred. Notwithstanding the foregoing provisions of this Section, in the event any such Series 2015A Bond shall have matured, and no default has occurred which is then continuing in the payment of the principal of, redemption premium, if any, or interest on the Series 2015A Bond, the Issuer may authorize the payment of the same (without surrender thereof except in the case of a damaged or mutilated Series 2015A Bond) instead of issuing a replacement Series 2015A Bond, provided security or indemnity is furnished as above provided in this Section.

(d) Charge for Issuing Replacement Bonds. Prior to the issuance of any replacement bond, the Paying Agent/Registrar shall charge the registered owner of such Series 2015A Bond with all legal, printing, and other expenses in connection therewith. Every replacement bond issued pursuant to the provisions of this Section by virtue of the fact that any Series 2015A Bond is lost, stolen, or destroyed shall constitute a contractual obligation of the Issuer whether or not the lost, stolen, or destroyed Series 2015A Bond shall be found at any time, or be enforceable by anyone, and

shall be entitled to all the benefits of this Resolution equally and proportionately with any and all other Series 2015A Bonds duly issued under this Resolution.

(e) Authority for Issuing Replacement Bonds. In accordance with Chapter 1201, Texas Government Code, this Section of this Resolution shall constitute authority for the issuance of any such replacement bond without necessity of further action by the governing body of the Issuer or any other body or person, and the duty of the replacement of such bonds is hereby authorized and imposed upon the Paying Agent/Registrar, and the Paying Agent/Registrar shall authenticate and deliver such Series 2015A Bonds in the form and manner and with the effect, as provided in this Resolution for Series 2015A Bonds issued in conversion and exchange for other Series 2015A Bonds.

Section 26. CUSTODY, APPROVAL, AND REGISTRATION OF SERIES 2015A BONDS; BOND COUNSEL'S OPINION, CUSIP NUMBERS, AND PREAMBLE. The President of the Board of Directors of the Issuer is hereby authorized to have control of the Initial Bond issued hereunder and all necessary records and proceedings pertaining to said Initial Bond pending its delivery and its investigation, examination, and approval by the Attorney General of the State of Texas, and its registration by the Comptroller of Public Accounts of the State of Texas. Upon registration of said Initial Bond said Comptroller of Public Accounts (or a deputy designated in writing to act for said Comptroller) shall manually sign the Comptroller's Registration Certificate on said Initial Bond, and the seal of said Comptroller shall be impressed, or placed in facsimile, on said Initial Bond. The approving legal opinion of the Issuer's Bond Counsel and the assigned CUSIP numbers may, at the option of the Issuer, be printed on said Initial Bond or on any Series 2015A Bonds issued and delivered in conversion of and exchange or replacement of any Series 2015A Bond, but neither shall have any legal effect, and shall be solely for the convenience and information of the registered owners of the Series 2015A Bonds. The preamble to this Resolution is hereby adopted and made a part hereof for all purposes.

Section 27. COVENANTS REGARDING TAX EXEMPTION. (a) Covenants. The Issuer covenants to take any action necessary to assure, or refrain from any action that would adversely affect, the treatment of the Series 2015A Bonds as obligations described in section 103 of the Internal Revenue Code of 1986, as amended (the "Code"), the interest on which is not includable in the "gross income" of the Series 2015A Bonds holder for purposes of federal income taxation. In furtherance thereof, the Issuer covenants as follows:

(1) to take any action to assure that no more than 10 percent of the proceeds of the Series 2015A Bonds (less amounts deposited to a reserve fund, if any) are used for any "private business use," as defined in section 141(b)(6) of the Code or, if more than 10 percent of the proceeds or the projects financed therewith are so used, such amounts, whether or not received by the Issuer, with respect to such private business use, do not, under the terms of this Resolution or any underlying arrangement, directly or indirectly, secure or provide for the payment of more than 10 percent of the debt service on the Series 2015A Bonds, in contravention of section 141(b)(2) of the Code;

(2) to take any action to assure that in the event that the "private business use" described in subsection (1) hereof exceeds 5 percent of the proceeds of the Series 2015A

Bonds or the projects financed therewith (less amounts deposited into a reserve fund, if any) then the amount in excess of 5 percent is used for a "private business use" that is "related" and not "disproportionate," within the meaning of section 141(b)(3) of the Code, to the governmental use;

(3) to take any action to assure that no amount that is greater than the lesser of $5,000,000, or 5 percent of the proceeds of the Series 2015A Bonds (less amounts deposited into a reserve fund, if any) is directly or indirectly used to finance loans to persons, other than state or local governmental units, in contravention of section 141(c) of the Code;

(4) to refrain from taking any action that would otherwise result in the Series 2015A Bonds being treated as "private activity bonds" within the meaning of section 141(b) of the Code;

(5) to refrain from taking any action that would result in the Series 2015A Bonds being "federally guaranteed" within the meaning of section 149(b) of the Code;

(6) to refrain from using any portion of the proceeds of the Series 2015A Bonds, directly or indirectly, to acquire or to replace funds that were used, directly or indirectly, to acquire investment property (as defined in section 148(b)(2) of the Code) that produces a materially higher yield over the term of the Series 2015A Bonds, other than investment property acquired with –

(A) proceeds of the Series 2015A Bonds invested for a reasonable temporary period of 3 years or less or, in the case of a refunding bond, for a period of 90 days or less until such proceeds are needed for the purpose for which the Series 2015A Bonds are issued,

(B) amounts invested in a bona fide debt service fund, within the meaning of section 1.148-1(b) of the Treasury Regulations, and

(C) amounts deposited in any reasonably required reserve or replacement fund to the extent such amounts do not exceed 10 percent of the proceeds of the Series 2015A Bonds;

(7) to otherwise restrict the use of the proceeds of the Series 2015A Bonds or amounts treated as proceeds of the Series 2015A Bonds, as may be necessary, so that the Series 2015A Bonds do not otherwise contravene the requirements of section 148 of the Code (relating to arbitrage) and, to the extent applicable, section 149(d) of the Code (relating to advance refundings);

(8) to pay to the United States of America at least once during each five-year period (beginning on the date of delivery of the Series 2015A Bonds) an amount that is at least equal to 90 percent of the "Excess Earnings," within the meaning of section 148(f) of the Code and to pay to the United States of America, not later than 60 days after the Series

2015A Bonds have been paid in full, 100 percent of the amount then required to be paid as a result of Excess Earnings under section 148(f) of the Code; and

(b) Rebate Fund. In order to facilitate compliance with the above covenant (a)(8), a "Rebate Fund" is hereby established by the Issuer for the sole benefit of the United States of America, and such Fund shall not be subject to the claim of any other person, including without limitation the Bondholders. The Rebate Fund is established for the additional purpose of compliance with section 148 of the Code.

(c) Compliance with Code. For purposes of the foregoing covenants (a)(1) and (a)(2), the Issuer understands that the term "proceeds" includes "disposition proceeds" as defined in the Treasury Regulations and, in the case of refunding Series 2015A Bonds, transferred proceeds (if any) and proceeds of the refunded Series 2015A Bonds expended prior to the date of issuance of the refunding Series 2015A Bonds. It is the understanding of the Issuer that the covenants contained herein are intended to assure compliance with the Code and any regulations or rulings promulgated by the U.S. Department of the Treasury pursuant thereto. In the event that regulations or rulings are hereafter promulgated that modify or expand provisions of the Code, as applicable to the Series 2015A Bonds, the Issuer will not be required to comply with any covenant contained herein to the extent that such failure to comply, in the opinion of nationally recognized bond counsel, will not adversely affect the exemption from federal income taxation of interest on the Series 2015A Bonds under section 103 of the Code. In the event that regulations or rulings are hereafter promulgated that impose additional requirements applicable to the Series 2015A Bonds, the Issuer agrees to comply with the additional requirements to the extent necessary, in the opinion of nationally recognized bond counsel, to preserve the exemption from federal income taxation of interest on the Series 2015A Bonds under section 103 of the Code. In furtherance of such intention, the Issuer hereby authorizes and directs the President of the Board of Directors, the General Manager, or the Director of Finance to execute any documents, certificates or reports required by the Code and to make such elections, on behalf of the Issuer, that may be permitted by the Code as are consistent with the purpose for the issuance of the Series 2015A Bonds.

(d) Written Procedures. Unless superseded by another action of the Issuer to ensure compliance with the covenants contained herein regarding private business use, remedial actions, arbitrage and rebate, the Issuer hereby adopts and establishes the instructions attached hereto as Exhibit A as their written procedures applicable to the Bonds and any Additional Bonds.

Section 28. ALLOCATION OF, AND LIMITATION ON, EXPENDITURES FOR THE PROJECT. The Issuer covenants to account for the expenditure of sale proceeds and investment earnings to be used for the purposes described in Section 1 of this Resolution (the "Project") on its books and records by allocating proceeds to expenditures within 18 months of the later of the date that (1) the expenditure is made, or (2) the Project is completed. The foregoing notwithstanding, the Issuer shall not expend sale proceeds or investment earnings thereon more than 60 days after the earlier of (1) the fifth anniversary of the delivery of the Series 2015A Bonds, or (2) the date the Series 2015A Bonds are retired, unless the Issuer obtains an opinion of nationally-recognized bond counsel that such expenditure will not adversely affect the tax-exempt status of the Series 2015A Bonds. For purposes hereof, the Issuer shall not be obligated to comply with this covenant if it

obtains an opinion that such failure to comply will not adversely affect the excludability for federal income tax purposes from gross income of the interest.

Section 29. DISPOSITION OF PROJECT. The Issuer covenants that the property constituting the Project will not be sold or otherwise disposed in a transaction resulting in the receipt by the Issuer of cash or other compensation, unless the Issuer obtains an opinion of nationally-recognized bond counsel that such sale or other disposition will not adversely affect the tax-exempt status of the Series 2015A Bonds. For purposes of the foregoing, the portion of the property comprising personal property and disposed in the ordinary course shall not be treated as a transaction resulting in the receipt of cash or other compensation. For purposes hereof, the Issuer shall not be obligated to comply with this covenant if it obtains an opinion that such failure to comply will not adversely affect the excludability for federal income tax purposes from gross income of the interest.

Section 30. CONTINUING DISCLOSURE. (a) Definitions. As used in this Section, the following terms have the meanings ascribed to such terms below:

"*Authority*" means Trinity River Authority.

"*Cities*" means the Cities of Arlington, Fort Worth and Mansfield.

"*MSRB*" means the Municipal Securities Rulemaking Board.

"*Rule*" means SEC Rule 15c2-12, as amended from time to time.

"*SEC*" means the United States Securities and Exchange Commission.

(b) General. Pursuant to a Continuing Disclosure Agreement by and among the Issuer, the Cities, and the Authority, the Issuer, the Cities and the Authority have undertaken for the benefit of the beneficial owners of the Series 2015A Bonds, to the extent set forth therein, to provide continuing disclosure of financial information and operating data with respect to the Issuer, Cities and Authority in accordance with the Rule as promulgated by the SEC.

(c) Annual Reports. (i) The Issuer shall provide annually to the MSRB, within six months after the end of each fiscal year ending in or after 2015, financial information and operating data with respect to the Issuer of the general type described in Exhibit B hereto. Any financial statements so to be provided shall be prepared in accordance with the accounting principles described in Exhibit B thereto, or such other accounting principles as the Issuer may be required to employ from time to time pursuant to state law or regulation, and audited, if the Issuer commissions an audit of such statements and the audit is completed within the period during which they must be provided. If the audit of such financial statements is not complete within such period, then the Issuer shall provide audited financial statements for the applicable fiscal year to the MSRB, when and if the audit report on such statements become available.

(ii) If the Issuer changes its fiscal year, it will notify the MSRB of the change (and of the date of the new fiscal year end) prior to the next date by which the Issuer otherwise would be required to provide financial information and operating data pursuant to this Section. The financial

information and operating data to be provided pursuant to this Section may be set forth in full in one or more documents or may be included by specific reference to any document (including an official statement or other offering document, if it is available from the MSRB) that theretofore has been provided to the MSRB, or filed with the SEC.

(d) Disclosure Event Notices. The Issuer shall notify the MSRB, in a timely manner, of any of the following events with respect to the Series 2015A Bonds, not in excess of ten Business Days after occurrence of the event:

1. Principal and interest payment delinquencies;

2. Non-payment related defaults, if material;

3. Unscheduled draws on debt service reserves reflecting financial difficulties;

4. Unscheduled draws on credit enhancements reflecting financial difficulties;

5. Substitution of credit or liquidity providers, or their failure to perform;

6. Adverse tax opinions, the issuance by the Internal Revenue Service of proposed or final determinations of taxability, Notices of Proposed Issue (IRS Form 5701-TEB) or other material notices or determinations with respect to the tax status of the security, or other material events affecting the tax status of the security;

7. Modifications to the rights of security holders, if material;

8. Bond calls, if material, and tender offers;

9. Defeasances;

10. Release, substitution or sale of property securing repayment of the securities, if material;

11. Rating changes;

12. Bankruptcy, insolvency, receivership or similar event of the Issuer, any of the Cities or the Authority;

13. The consummation of a merger, consolidation, or acquisition involving the Issuer or the sale of all or substantially all of the assets of the Issuer, any of the Cities, or the Authority, other than in the ordinary course of business, the entry into a definitive agreement to undertake such an action or the termination of a definitive agreement relating to any such actions, other than pursuant to its terms, if material; and

14. Appointment of a successor or additional trustee or the change of name of a trustee, if material.

The Issuer shall notify the MSRB, in a timely manner, of any failure by the Issuer to provide financial information or operating data in accordance with Section 30(c) of this Resolution by the time required by such Section. As used in clause 12 above, the phrase "bankruptcy, insolvency, receivership or similar event" means the appointment of a receiver, fiscal agent, or similar officer for the Issuer in a proceeding under the U.S. Bankruptcy Code or in any other proceeding under state or federal law in which a court or governmental authority has assumed jurisdiction over substantially all of the assets or business of the Issuer, or if jurisdiction has been assumed by leaving the Board of Directors and official or officers of the Issuer in possession but subject to the supervision and orders of a court or governmental authority, or the entry of an order confirming a plan of reorganization, arrangement or liquidation by a court or governmental authority having supervision or jurisdiction over substantially all of the assets or business of the Issuer.

(e) Limitations, Disclaimers, and Amendments. (i) The Issuer shall be obligated to observe and perform the covenants specified in this Section for so long as, but only for so long as, the Issuer remains an "obligated person" with respect to the Series 2015A Bonds within the meaning of the Rule, except that the Issuer in any event will give notice of any deposit made in accordance with this Resolution or applicable law that causes Series 2015A Bonds no longer to be outstanding.

(ii) The provisions of this Section are for the sole benefit of the holders and beneficial owners of the Series 2015A Bonds, and nothing in this Section, express or implied, shall give any benefit or any legal or equitable right, remedy, or claim hereunder to any other person. The Issuer undertakes to provide only the financial information, operating data, financial statements, and notices which it has expressly agreed to provide pursuant to this Section and does not hereby undertake to provide any other information that may be relevant or material to a complete presentation of the Issuer's financial results, condition, or prospects or hereby undertake to update any information provided in accordance with this Section or otherwise, except as expressly provided herein. The Issuer does not make any representation or warranty concerning such information or its usefulness to a decision to invest in or sell Series 2015A Bonds at any future date.

(iii) UNDER NO CIRCUMSTANCES SHALL THE ISSUER BE LIABLE TO THE HOLDER OR BENEFICIAL OWNER OF ANY SERIES 2015A BOND OR ANY OTHER PERSON, IN CONTRACT OR TORT, FOR DAMAGES RESULTING IN WHOLE OR IN PART FROM ANY BREACH BY THE ISSUER, WHETHER NEGLIGENT OR WITHOUT FAULT ON ITS PART, OF ANY COVENANT SPECIFIED IN THIS SECTION, BUT EVERY RIGHT AND REMEDY OF ANY SUCH PERSON, IN CONTRACT OR TORT, FOR OR ON ACCOUNT OF ANY SUCH BREACH SHALL BE LIMITED TO AN ACTION FOR MANDAMUS OR SPECIFIC PERFORMANCE.

(iv) No default by the Issuer in observing or performing its obligations under this Section shall comprise a breach of or default under this Resolution for purposes of any other provision of this Resolution. Nothing in this Section is intended or shall act to disclaim, waive, or otherwise limit the duties of the Issuer under federal and state securities laws.

(v) The provisions of this Section may be amended by the Issuer from time to time to adapt to changed circumstances that arise from a change in legal requirements, a change in law, or a change in the identity, nature, status, or type of operations of the Issuer, but only if (1) the provisions

of this Section, as so amended, would have permitted an underwriter to purchase or sell Series 2015A Bonds in the primary offering of the Series 2015A Bonds in compliance with the Rule, taking into account any amendments or interpretations of the Rule since such offering as well as such changed circumstances and (2) either (a) the holders of a majority in aggregate principal amount (or any greater amount required by any other provision of this Resolution that authorizes such an amendment) of the Outstanding Series 2015A Bonds consent to such amendment or (b) a person that is unaffiliated with the Issuer (such as bond counsel) determines that such amendment will not materially impair the interest of the holders and beneficial owners of the Series 2015A Bonds. If the Issuer so amends the provisions of this Section, it shall include with any amended financial information or operating data next provided in accordance with subsection (a) of this Section an explanation, in narrative form, of the reason for the amendment and of the impact of any change in the type of financial information or operating data so provided. The Issuer may also amend or repeal the provisions of this continuing disclosure agreement if the SEC amends or repeals the applicable provision of the Rule or a court of final jurisdiction enters judgment that such provisions of the Rule are invalid, but only if and to the extent that the provisions of this sentence would not prevent an underwriter from lawfully purchasing or selling Series 2015A Bonds in the primary offering of the Series 2015A Bonds.

Section 31. INTEREST EARNINGS ON SERIES 2015A BOND PROCEEDS. Interest earnings derived from the investment of proceed from the sale of the Series 2015A Bonds shall be used along with other bond proceeds from the acquisition and consruction of the Project; provided that afer completion of the Project, if any of such interest earnings remain on hand, such interest earnings shall be deposited in the Interest and Redemption fund. It is further provided, however, that any interest earnings on bond proceeds which are required to be rebated to the United States of America pursuant to this Resolution in order to prevent the Series 2015A Bonds from being arbitrage bonds shall be so rebated and not considered as interest earnings for the purposes of this Section.

Section 32. ESCROW AGREEMENT. If required by the TWDB as a condition to the purchase of the Bonds, the President, any Vice President, the Secretary, and/or the General Manager is authorized to execute and deliver an escrow agreement in substantially the form attached as Exhibit C. In such case, proceeds of the Bonds required to be deposited under an escrow agreement shall be disposed of and released in accordance with TWDB Rules Relating to Financial Programs or as otherwise authorized and directed by the TWDB.

Section 33. SALE OF SERIES 2015A BONDS. The Series 2015A Bonds are hereby sold and shall be delivered to the TWDB at a purchase price equal to 100% of the principal amount thereof. The officers of the Issuer are authorized to do any and all things necessary in connection with the issuance of the Series 2015A Bonds, and are authorized to execute and deliver such certificates as are necessary or appropriate in connection with the issuance of the Series 2015A Bonds. It is hereby officially found, determined, and declared that the terms of this sale are the most advantageous reasonably obtainable. The Initial Bond shall be registered in the name of the TWDB or its designee.

Section 34. TWDB REQUIREMENTS. The Issuer covenants and agrees, so long as the TWDB owns all of the Series 2015A Bonds, as follows:

(a) FINAL ACCOUNTING. The Issuer shall render a final accounting to the TWDB in reference to the total costs incurred by the Issuer with proceeds of the Series 2015A Bonds.

(b) SURPLUS BOND PROCEEDS. To the extent that any proceeds of the Series 2015A Bonds remain after payment of all costs to be paid with proceeds of the Series 2015A Bonds, such surplus proceeds shall be used to purchase or redeem and cancel the Series 2015A Bonds, in inverse order of their maturity, owned by the TWDB; provided that any remaining amounts less than $5,000 shall be deposited to the Interest and Sinking Fund.

(c) ANNUAL REPORTS. Annual audits of the Issuer required by Section 23(k) hereof shall be delivered to the TWDB within 120 days of the close of each fiscal year.

(d) COMPLIANCE WITH THE TWDB'S RULES AND REGULATIONS. The Issuer shall comply with the rules and regulations of the TWDB, and shall maintain any insurance, in addition to that required by Section 23(h) of this Resolution, on the District's Water System in an amount determined by the TWDB to be sufficient to protect the TWDB's interest. Additionally, the Issuer covenants to invest the proceeds received from the sale of the Series 2015A Bonds only in accordance with the Public Funds Investment Act, Chapter 2256, Texas Government Code, as amended, and to secure such proceeds as required by the Public Securities Collateral Act, Chapter 2257, Texas Government Code, as amended.

(e) CONSTRUCTION FUND. The Issuer shall maintain on its books a Construction Fund, separate and apart from all other funds of the District, into which it shall deposit and disburse proceeds of the Series 2015A Bonds (except for any proceeds required by this Resolution to be deposited into the Interest and Redemption Fund and the Reserve Fund).

(f) ENVIRONMENTAL INDEMNIFICATION. The Issuer agrees to indemnify, hold harmless, and protect the TWDB from any and all claims, causes of action or damages to the person or property of third parties arising from the sampling, analysis, transport and/or removal and disposition of any contaminated sewage sludge, contaminated sediments and/or contaminated media that may be generated by the Issuer, its contractors, consultants, agents, officials and employees as a result of activities relating to the project financed with proceeds of the Series 2015A Bonds to the extent permitted by law.

(g) WATER CONSERVATION PLAN. The Issuer will implement and/or assist in the implementation of water conservation plans approved by the TWDB.

Section 35. ATTORNEY GENERAL FEES. The Issuer hereby authorizes and directs payment, from legally available funds of the Issuer, of the nonrefundable examination fee of the Attorney General of the State of Texas required by Section 1202.004, Texas Government Code, as amended.

Section 36. FURTHER PROCEDURES. The President and the Secretary of the Board of Directors and the General Manager and the Finance Director of the Issuer, and all other officers, employees, and agents of the Issuer, and each of them, shall be and they are hereby expressly authorized, empowered, and directed from time to time and at any time to do and perform all such

acts and things and to execute, acknowledge, and deliver in the name and on behalf of the Issuer all such instruments, whether or not herein mentioned, as may be necessary or desirable in order to carry out the terms and provisions of this Resolution, and all details in connection therewith. In case any officer whose signature shall appear on any Series 2015A Bond shall cease to be such officer before the delivery of such Series 2015A Bond, such signature shall nevertheless be valid and sufficient for all purposes the same as if such officer had remained in office until such delivery.

Section 37. REPEAL OF CONFLICTING RESOLUTIONS. All resolutions and all parts of any resolutions which are in conflict or inconsistent with this Resolution are hereby repealed and shall be of no further force or effect to the extent of such conflict or inconsistency.

Section 38. PUBLIC NOTICE. It is hereby officially found and determined that public notice of the time, place and purpose of said meeting was given, all as required by the Government Code, Chapter 551.

EXHIBIT "A"

WRITTEN PROCEDURES RELATING TO CONTINUING
COMPLIANCE WITH FEDERAL TAX COVENANTS

A. Arbitrage. With respect to the investment and expenditure of the proceeds of the Series 2015A Bonds and any Additional Bonds (the "Obligations") the Issuer's General Manager, Assistant General Manager, and Director of Finance (the "Responsible Persons") will :

For Obligations issued for newly acquired property or constructed property:

- instruct the appropriate person or persons that the construction, renovation or acquisition of the facilities must proceed with due diligence and that binding contracts for the expenditure of at least 5%of the proceeds of the Obligations will be entered into within 6 months of the Issue Date;
- monitor that at least 85% of the proceeds of the Obligations to be used for the construction, renovation or acquisition of any facilities are expended within 3 years of the date of delivery of the Obligations ("Issue Date");
- restrict the yield of the investments (other than those in the Reserve Fund) to the yield on the Obligations after 3 years of the Issue Date;
- monitor all amounts deposited into a sinking fund or funds, e.g., the Interest and Redemption Fund and the Reserve Fund, to assure that the maximum amount invested at a yield higher than the yield on the Obligations does not exceed an amount equal to the debt service on the Obligations in the succeeding 12 month period plus a carryover amount equal to one-twelfth of the principal and interest payable on the Obligations for the immediately preceding 12-month period;
- assure that no more than 50% of the proceeds of the Obligations are invested in an investment with a guaranteed yield for 4 years or more;
- assure that the maximum amount of the Reserve Fund invested at a yield higher than the yield on the Obligations will not exceed the lesser of (1) 10% of the original principal amount of the Obligations, (2) 125% of the average annual debt service on the Obligations measured as of the Issue Date, or (3) 100% of the maximum annual debt service on the Obligations as of the Issue Date;

For Obligations issued for refunding purposes:

- monitor the actions of the escrow agent (to the extent an escrow is funded with proceeds) to assure compliance with the applicable provisions of the escrow agreement, including with respect to reinvestment of cash balances;

For all Obligations:

- maintain any official action of the Issuer (such as a reimbursement resolution) stating its intent to reimburse itself or the City with the proceeds of the Obligations any amount expended prior to the Issue Date for the acquisition, renovation or construction of the facilities;

- assure that the applicable information return (e.g., IRS Form 8038-G, 8038-GC, or any successor forms) is timely filed with the IRS;

- assure that, unless excepted from rebate and yield restriction under section 148(f) of the Code, excess investment earnings are computed and paid to the U.S. government at such time and in such manner as directed by the IRS (i) at least every 5 years after the Issue Date and (ii) within 30 days after the date the Obligations are retired.

B. Private Business Use. With respect to the use of the facilities financed or refinanced with the proceeds of the Obligations the Responsible Persons will:

- monitor the date on which the facilities are substantially complete and available to be used for the purpose intended;

- monitor whether, at any time the Obligations are outstanding, any person, other than the Issuer or the City, the employees of the Issuer or the City, the agents of the Issuer or the City or members of the general public has any contractual right (such as a lease, purchase, management or other service agreement) with respect to any portion of the facilities;

- monitor whether, at any time the Obligations are outstanding, any person, other than the Issuer or the City, the employees of the Issuer or the City, the agents of the Issuer or the City or members of the general public has a right to use the output of the facilities (e.g., water, gas, electricity);

- monitor whether, at any time the Obligations are outstanding, any person, other than the Issuer or the City, the employees of the Issuer or the City, the agents of the Issuer or the City or members of the general public has a right to use the facilities to conduct or to direct the conduct of research;

- determine whether, at any time the Obligations are outstanding, any person, other than the Issuer or the City, has a naming right for the facilities or any other contractual right granting an intangible benefit;

- determine whether, at any time the Obligations are outstanding, the facilities are sold or otherwise disposed of; and

- take such action as is necessary to remediate any failure to maintain compliance with the covenants contained in the resolution authorizing the Obligations.

C. Record Retention. The Responsible Persons will maintain or cause to be maintained all records relating to the investment and expenditure of the proceeds of the Obligations and the use of the facilities financed or refinanced

thereby for a period ending three (3) years after the complete extinguishment of the Obligations. If any portion of the Obligations is refunded with the proceeds of another series of tax-exempt obligations, such records shall be maintained until the three (3) years after the refunding obligations are completely extinguished. Such records can be maintained in paper or electronic format.

D. Responsible Persons. Each Responsible Person shall receive appropriate training regarding the Issuer's accounting system, contract intake system, facilities management and other systems necessary to track the investment and expenditure of the proceeds and the use of the facilities financed with the proceeds of the Obligations. The foregoing notwithstanding, the Responsible Persons are authorized and instructed to retain such experienced advisors and agents as may be necessary to carry out the purposes of these instructions.

EXHIBIT "B"

DESCRIPTION OF ANNUAL FINANCIAL INFORMATION

The following information is referred to in Section 30 of this Resolution.

I. Annual Financial Statements and Operating Data of the Issuer

The financial information and operating data with respect to the Issuer to be provided annually in accordance with such Section are as specified.

Accounting Principles

The accounting principles referred to in such Section are the accounting principles described in the notes to the financial statements referred to in paragraph 1 above.

EXHIBIT "C"

ESCROW AGREEMENT

PRIVATE PLACEMENT MEMORANDUM DATED _____, 2015

NEW ISSUE BOOK-ENTRY-ONLY

On the date of initial delivery of the Obligations (defined below), Issuer Bond Counsel (defined on page 2) will render its opinion substantially in the form attached in APPENDIX C - FORM OF OPINION OF BOND COUNSEL.

$300,000,000
TARRANT REGIONAL WATER DISTRICT,
A WATER CONTROL AND IMPROVEMENT DISTRICT,
WATER REVENUE BONDS, SERIES 2015A
(the "Obligations")

Dated: _____, 2015 **Due: March 1**

Interest Date:	Interest on the Obligations will be payable on March 1, 2016, and on each September 1 and March 1 each year thereafter until maturity or prior redemption (each an "Interest Payment Date"). The Obligations will bear interest at the rates per annum set forth in "APPENDIX A - MATURITY SCHEDULE."
Record Date:	The close of business on the fifteenth business day of the calendar month immediately preceding the applicable Interest Payment Date.
Date Interest Accrues:	Each Bond shall bear interest from the Delivery Date thereof or the most recent Interest Payment Date to which interest has been paid or provided for at the rate set forth, such maturity.
Redemption:	The Obligations are subject to redemption prior to maturity as provided herein. See "THE OBLIGATIONS - Redemption Provisions" herein.
Authorized Denominations:	The Obligations are being issued as fully registered bonds in denominations of $5,000, or any integral multiple thereof.
Paying Agent/Registrar/Registrar:	The paying agent ("Paying Agent/Registrar/Registrar") for the Obligations is BOKF, NA dba Bank of Texas, Austin, Texas.
Book-Entry-Only System	Upon initial issuance, the ownership of the Obligations will be registered in the registration books of Tarrant Regional Water District (the "Issuer") kept by the Paying Agent/Registrar, in the name of Cede & Co., as nominee of The Depository Trust Company, New York, New York ("DTC") to which principal, redemption premium, if any, and interest payments on the Obligations will be made. The purchasers of the Obligations will not receive physical delivery of bond certificates. Principal of, interest, and premium if any, on the Obligations will be payable at the designated office of the Paying Agent/Registrar in Austin, Texas as the same become due and payable.
Issuer:	Tarrant Regional Water District, a Water Control and Improvement District, created and functioning under Article 16, Section 59, of the Texas Constitution, pursuant to the general laws of the State of Texas, including Chapters 49 and 51, Texas Water Code, and pursuant to the provisions of Chapter 268, Acts of 1957, 55th Legislature of Texas, Regular Session, as amended (collectively, the "District Act").
Official Action:	Resolution Authorizing the Issuance, Sale and Delivery of Tarrant Regional Water District, a Water Control and Improvement District, Water System Revenue Bonds, Series 2015A, dated _____,2015.
Purpose:	The Obligations are being issued for the purpose of (i) to pay for construction, improvements, and extensions to the District's Water System, including design, acquisition, and construction of an integrated pipeline to serve the City of Dallas and the District; (ii) to fund a debt service reserve fund; and (iii) to pay costs of issuance of the Series 2015A Bonds.
Security for the Obligations:	See "SECTION ___ PLEDGE" OF "APPENDIX B – FORM OF OFFICIAL ACTION."
Ratings:	See "OTHER INFORMATION - Ratings"
Delivery Date:	_____, 2015.

See "APPENDIX A - MATURITY SCHEDULE" for Principal Amounts,

Maturities, Interest Rates, Prices or Yields, and Initial CUSIP Numbers

TARRANT REGIONAL WATER DISTRICT
A WATER CONTROL AND IMPROVEMENT DISTRICT

BOARD OF DIRECTORS

Victor W. Henderson ..... President

Jack R. Stevens ..... Vice President

Martha V. Leonard ..... Secretary

James W. Lane. ..... Secretary Pro Tem

Mary Kelleher ..... Director

MANAGEMENT OFFICERS

James M. Oliver ..... General Manager

Alan Thomas ..... Deputy General Manager

Sandra Newby ..... Finance Director

McCall, Parkhurst & Horton L.L.P., Co-Bond Counsel
Newby Davis PLLC, Co-Bond Counsel

First Southwest Company, LLC, Co-Financial Advisor
Kipling Jones & Co., Co- Financial Advisor

BOKF, NA dba Bank of Texas, Paying Agent/Registrar

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Private Placement Memorandum
relating to

$300,000,000

TARRANT REGIONAL WATER DISTRICT,
A WATER CONTROL AND IMPROVEMENT DISTRICT,
WATER REVENUE BONDS, SERIES 2015A
(the "Obligations")

INTRODUCTION

This Private Placement Memorandum, including the cover page and appendices, contains brief descriptions of the Issuer, provides certain information with respect to the issuance by the Issuer, and summaries of certain provisions of the "Obligations" pursuant to the Official Action. Except as otherwise set forth herein, capitalized terms used but not defined in this Private Placement Memorandum have the meanings assigned to them in the Official Action. See "APPENDIX B – "FORM OF OFFICIAL ACTION" attached hereto.

APPENDIX A contains the maturity schedule for the Obligations. APPENDIX B contains the Official Action and a description of the purpose for the proceeds of the Obligations. APPENDIX C contains a copy of the proposed opinion of Bond Counsel with respect to the Obligations. The summaries of the documents contained in the forepart of this Private Placement Memorandum are not complete or definitive, and every statement made in this Private Placement Memorandum concerning any provision of any document is qualified by reference to such document in its entirety.

THE OBLIGATIONS

General Description

The Obligations are being issued in the aggregate principal amount set forth in APPENDIX A of this Private Placement Memorandum and will mature and be subject to redemption prior to maturity as described therein. The Obligations are being issued as fully registered bonds in denominations of $5,000**,** or any integral multiple thereof. The Obligations will be dated as of the stated date of issue and will mature on the dates referenced thereon, and will bear interest at the rates per annum set forth in "APPENDIX A - MATURITY SCHEDULE."

Interest on the Obligations is payable semiannually on each Interest Payment Date, and will be calculated on the basis of a 360-day year consisting of twelve 30-day months. Principal of and the redemption price with respect to the Obligations will be payable to the Owners upon presentation and surrender at the principal office of the Paying Agent/Registrar.

Purpose

See "APPENDIX B - FORM OF OFFICIAL ACTION."

Authority for Issuance

The Obligations are issued pursuant to the general laws of the State of Texas, including Chapters 49 and 51, Texas Water Code, as amended, pursuant to the provisions of the District Act, and pursuant to the Official Action.

Security for the Obligations

See "APPENDIX B - FORM OF OFFICIAL ACTION."

Redemption Provisions

On March 1, 2027, or on any date thereafter, the Obligations maturing on and after March 1, 2026 may be redeemed prior to their scheduled maturities, upon the written direction of the Issuer, with funds provided by the Issuer, at par plus accrued interest to the date fixed for redemption as a whole, or in part, and if less than all of a maturity is to be redeemed the Paying Agent/Registrar will determine by lot the Obligations, or portions thereof within such maturity to be redeemed (provided that a portion of a Bond may be redeemed only in Authorized Denominations).

Notice of Redemption; Selection of Obligations to Be Redeemed

See "APPENDIX B - FORM OF OFFICIAL ACTION."

The Paying Agent/Registrar, so long as a Book-Entry-Only System is used for the Bonds, will send any notice of redemption of the Bonds, notice of any proposed amendment to the Official Action or other notices with respect to the Bonds only to DTC. Any failure by DTC to advise any DTC Participant (defined below), or of any DTC participant to notify the beneficial owner, shall not affect the validity of the redemption of the Bonds called for redemption or any other action premised on any such notice. Redemption of portions of the Bonds by the Issuer will reduce the outstanding principal amount of such Bonds held by DTC.

Book-Entry-Only System

The information in this caption concerning The Depository Trust Company, New York, New York ("DTC") and DTC's book entry system has been obtained from DTC and the Issuer makes no representation or warranty nor takes any responsibility for the accuracy or completeness of such information.

DTC will act as securities depository for the Obligations. The Obligations will be issued as fully-registered securities registered in the name of Cede & Co. (DTC's partnership nominee) or such other name as may be requested by an authorized representative of DTC. One fully-registered certificate will be issued for each maturity of the Obligations and deposited with DTC. See APPENDIX B - "FORM OF OFFICIAL ACTION."

DTC is a limited-purpose trust company organized under the New York Banking Law, a "banking organization" within the meaning of the New York Banking Law, a member of the Federal Reserve System, a "clearing corporation" within the meaning of the New York Uniform Commercial Code, and a "clearing agency" registered pursuant to the provisions of Section 17A of the Securities Exchange Act of 1934. DTC holds and provides asset servicing for over 3.5 million issues of U.S. and non-U.S. equity, corporate and municipal debt issues, and money market instrument (from over 100 countries) that DTC's participants (the "Direct Participants") deposit with DTC. DTC also facilitates the post-trade settlement among Direct Participants of sales and other securities transactions, in deposited securities, through electronic computerized book entry transfers and pledges between Direct Participants' accounts. This eliminates the need for physical movement of securities certificates. Direct Participants include both U.S. and non-U.S. securities brokers and dealers, banks, trust companies, clearing corporations, and certain other organizations. DTC is a wholly-owned subsidiary of The Depository Trust & Clearing Corporation ("DTCC"). DTCC is the holding company for DTC, National Securities Clearance Corporation, and Fixed Income Clearance Corporation, all of which are registered clearing agencies. DTCC is owned by the users of its regulated subsidiaries. Access to the DTC system is also available to others such as both U.S. and non-U.S. securities brokers and dealers, banks, trust companies, and clearing corporations that clear through or maintain a custodial relationship with a Direct Participant, either directly or indirectly ("Indirect Participants"). Direct Participants and Indirect Participants are referred to herein collectively as "Participants". DTC has a Standard & Poor's rating of "AA+". The DTC Rules applicable to its Participants are on file with the Securities and Exchange Commission. More information about DTC can be found at www.dtcc.com and www.dtc.org.

Purchases of Obligations under the DTC system must be made by or through Direct Participants, which will receive a credit for the Obligations on DTC's records. The ownership interest of each actual purchaser of each Bond ("Beneficial Owner") is in turn to be recorded on the Participants' records. Beneficial Owners will not receive written confirmation from DTC of their purchase. Beneficial Owners are, however, expected to receive written confirmations providing details of the transaction, as well as periodic statements of their holdings, from the Participant through which the Beneficial Owner entered into the transaction.

Transfers of ownership interests in the Obligations are to be accomplished by entries made on the books of Participants acting on behalf of Beneficial Owners. Beneficial Owners will not receive Obligations representing their ownership interests in Obligations, except in the event that use of the book-entry system for the Obligations is discontinued.

To facilitate subsequent transfers, all Obligations deposited by Direct Participants with DTC are registered in the name of DTC's partnership nominee, Cede & Co., or such other name as may be requested by an authorized

representative of DTC. The deposit of Obligations with DTC and their registration in the name of Cede & Co. or such other DTC nominee do not effect any change in beneficial ownership. DTC has no knowledge of the actual Beneficial Owners of the Obligations; DTC's records reflect only the identity of the Direct Participants to whose accounts such Obligations are credited, which may or may not be the Beneficial Owners. The Participants will remain responsible for keeping account of their holdings on behalf of their customers.

Conveyance of notices and other communications by DTC to Direct Participants, by Direct Participants to Indirect Participants, and by Direct Participants and Indirect Participants to Beneficial Owners will be governed by arrangements among them, subject to any statutory or regulatory requirements as may be in effect from time to time.

Redemption notices shall be sent to DTC. If less than all of the Obligations within a maturity are being redeemed, DTC's practice is to determine by lot the amount of the interest of each Direct Participant in such maturity to be redeemed.

Neither DTC nor Cede & Co. (nor any other DTC nominee) will consent or vote with respect to Obligations unless authorized by a Direct Participant in accordance with DTC's Money Market Instrument Procedures. Under its usual procedures, DTC mails an Omnibus Proxy to the Issuer as soon as possible after the record date. The Omnibus Proxy assigns Cede & Co.'s consenting or voting rights to those Direct Participants to whose accounts Obligations are credited on the record date (identified in a listing attached to the Omnibus Proxy).

All payments on the Obligations will be made to Cede & Co., or such other nominee as may be requested by an authorized representative of DTC. DTC's practice is to credit Direct Participants' accounts upon DTC's receipt of funds and corresponding detail information from the Issuer or the Paying Agent/Registrar, on payable date in accordance with their respective holdings shown on DTC's records. Payments by Participants to Beneficial Owners will be governed by standing instructions and customary practices, as is the case with Obligations held for the accounts of customers in bearer form or registered in "street name," and will be the responsibility of such Participant and not of DTC, the Paying Agent/Registrar, or the Issuer, subject to any statutory or regulatory requirements as may be in effect from time to time. All payments to Cede & Co. (or such other nominee as may be requested by an authorized representative of DTC) are the responsibility of the Issuer or the Paying Agent/Registrar, disbursement of such payments to Direct Participants will be the responsibility of DTC, and disbursement of such payments to the Beneficial Owners will be the responsibility of Participants.

DTC may discontinue providing its services as depository with respect to the Obligations at any time by giving reasonable notice to the Issuer or the Paying Agent/Registrar. Under such circumstances, in the event that a successor depository is not obtained, Obligations are required to be printed and delivered.

With the consent of the Texas Water Development Board, the Issuer may decide to discontinue use of the system of book-entry-only transfers through DTC (or a successor securities depository). In that event, Obligations will be printed and delivered to DTC or successor securities depository.

TAX MATTERS

Opinion

Bond Counsel will deliver its opinion on the date of delivery of the Obligations substantially in the form as attached in "APPENDIX C - FORM OF OPINION OF BOND COUNSEL."

OTHER INFORMATION

Forward Looking Statements

The statements contained in this Private Placement Memorandum, including the cover page, appendices, and any other information or documents provided by the Issuer, that are not purely historical, are forward-looking statements, including statements regarding the Issuer's assumptions, expectations, hopes, intentions, or strategies regarding the future. Any of such assumptions, expectations or hopes could be inaccurate and, therefore, there can be no assurance that the forward-looking statements included herein will prove to be accurate. Holders of the Bonds should not place undue reliance on forward-looking statements. All forward-looking statements included in this Private Placement Memorandum are based on information available to the Issuer on the date hereof, and the Issuer

assumes no obligation to update any such forward-looking statements. It is important to note that the Issuer's actual results could differ materially from those in such forward-looking statements.

Ratings

The existing outstanding water system revenue bonds of the District are rated "AAA" by Standard & Poor's Ratings Services, a Standard & Poor's Financial Services LLC business, "AA" by Fitch Ratings and "Aa1" by Moody's Investors Service, Inc. An explanation of the significance of such ratings may be obtained from the company furnishing the rating. The ratings reflect only the respective views of such rating companies, and the District makes no representation as to the appropriateness of the ratings. There is no assurance that such ratings will continue for any given period of time, or that they will not be revised downward or withdrawn entirely by either or both of such rating companies, if in the judgment of either or both companies, circumstances so warrant. Any such downward revision or withdrawal of such ratings, by either of them, may have an adverse effect on the market price of the Obligations. **No application has been made to any rating agency or municipal bond insurance company for qualification of the Obligations for ratings or municipal bond insurance, respectively.**

LITIGATION

There is no litigation, proceeding, inquiry, or investigation pending by or before any court or other governmental authority or entity (or, to the best knowledge of the Issuer, threatened) that adversely affects the power, authority or obligation of the Issuer to deliver the Bonds, the security for, or the validity of, the Bonds or the financial condition of the Issuer. On the date of initial delivery of Bonds, the Issuer will execute and deliver a certificate of like effect to the purchaser of the Bonds.

CONTINUING DISCLOSURE OF INFORMATION

In the Official Action, the Issuer has made the following agreement for the benefit of the holders and beneficial owners of the Obligations. The Issuer is required to observe the agreement for so long as it remains obligated to advance funds to pay the Obligations. Under the agreement, the Issuer will be obligated to provide certain updated financial information and operating data, and timely notice of specified material events, to certain other information vendors. SEE APPENDIX B - "FORM OF OFFICIAL ACTION."

Compliance with Prior Undertakings

During the last five years, the Issuer believes it has complied in all material respects with all continuing disclosure agreements made by it in accordance with the Rule.

MISCELLANEOUS

Any statements made in this Private Placement Memorandum involving matters of opinion or of estimates, whether or not so expressly stated, are set forth as such and not as representations of fact, and no representation is made that any of the estimates will be realized. Neither this Private Placement Memorandum nor any statement that may have been made verbally or in writing is to be construed as a contract with the owners of the Obligations.

The information contained above is neither guaranteed as to accuracy or completeness nor to be construed as a representation by the Issuer. The information and expressions of opinion herein are subject to change without notice and neither the delivery of this Private Placement Memorandum nor any sale made hereunder is to create, under any circumstances, any implication that there has been no change in the affairs of the Issuer or the Issuer from the date hereof.

The Private Placement Memorandum is submitted in connection with the sale of the securities referred to herein and may not be reproduced or used, as a whole or in part, for any other purpose.

ADDITIONAL INFORMATION

The Private Placement Memorandum speaks only as of its date and the information contained herein is subject to change. Descriptions of the Obligations and the Official Action and any other agreements and documents contained herein constitute summaries of certain provisions thereof and do not purport to be complete.

APPENDIX A

MATURITY SCHEDULE **CUSIP Prefix: 876443** [1]
(Due March 1)

Amount	Maturity March 1,	Rate	Yield	CUSIP Suffix	Amount	Maturity March 1,	Rate	Yield	CUSIP Suffix
$ 7,100,000	2017				$ 10,050,000	2032			
7,180,000	2018				10,385,000	2033			
7,280,000	2019				10,735,000	2034			
7,395,000	2020				11,105,000	2035			
7,520,000	2021				11,490,000	2036			
7,665,000	2022				11,905,000	2037			
7,825,000	2023				12,330,000	2038			
8,000,000	2024				12,770,000	2039			
8,185,000	2025				13,225,000	2040			
8,390,000	2026				13,700,000	2041			
8,620,000	2027				14,200,000	2042			
8,870,000	2028				14,715,000	2043			
9,140,000	2029				15,255,000	2044			
9,425,000	2030				15,810,000	2045			
9,730,000	2031								

(1) CUSIP is a registered trademark of the American Bankers Association. CUSIP data is provided by CUSIP Global Services, managed by Standard & Poor's Financial Services LLC on behalf of the American Bankers Association. This data is not intended to create a database and does not serve in any way as a substitute for the CUSIP services. Neither the Issuer nor the Co-Financial Advisors take any responsibility for the accuracy of CUSIP numbers.

APPENDIX B

FORM OF OFFICIAL ACTION

APPENDIX C

FORM OF OPINION OF BOND COUNSEL

PRIVATE PLACEMENT MEMORANDUM DATED _____, 2015

NEW ISSUE BOOK-ENTRY-ONLY

On the date of initial delivery of the Obligations (defined below), Issuer Bond Counsel (defined on page 2) will render its opinion substantially in the form attached in APPENDIX C - FORM OF OPINION OF BOND COUNSEL.

$140,000,000
TARRANT REGIONAL WATER DISTRICT,
A WATER CONTROL AND IMPROVEMENT DISTRICT,
WATER TRANSMISSION FACILITIES CONTRACT
REVENUE BONDS (CITY OF DALLAS PROJECT), SERIES 2015
(the "Obligations")

Dated: _____, 2015 **Due: September 1**

Interest Date:	Interest on the Obligations will be payable on March 1, 2016, and on each September 1 and March 1 each year thereafter until maturity or prior redemption (each an "Interest Payment Date"). The Obligations will bear interest at the rates per annum set forth in "APPENDIX A - MATURITY SCHEDULE."
Record Date:	The close of business on the fifteenth business day of the calendar month immediately preceding the applicable Interest Payment Date.
Date Interest Accrues:	Each Bond shall bear interest from the Delivery Date thereof or the most recent Interest Payment Date to which interest has been paid or provided for at the rate set forth, such maturity.
Redemption:	The Obligations are subject to redemption prior to maturity as provided herein. See "THE OBLIGATIONS - Redemption Provisions" herein.
Authorized Denominations:	The Obligations are being issued as fully registered bonds in denominations of $5,000, or any integral multiple thereof.
Paying Agent/Registrar/Registrar:	The paying agent ("Paying Agent/Registrar/Registrar") for the Obligations is BOKF, NA dba Bank of Texas, Austin, Texas.
Book-Entry-Only System	Upon initial issuance, the ownership of the Obligations will be registered in the registration books of Tarrant Regional Water District (the "Issuer") kept by the Paying Agent/Registrar, in the name of Cede & Co., as nominee of The Depository Trust Company, New York, New York ("DTC") to which principal, redemption premium, if any, and interest payments on the Obligations will be made. The purchasers of the Obligations will not receive physical delivery of bond certificates. Principal of, interest, and premium if any, on the Obligations will be payable at the designated office of the Paying Agent/Registrar in Austin, Texas as the same become due and payable.
Issuer:	Tarrant Regional Water District, a Water Control and Improvement District, created and functioning under Article 16, Section 59, of the Texas Constitution, pursuant to the general laws of the State of Texas, including Chapters 49 and 51, Texas Water Code, and pursuant to the provisions of Chapter 268, Acts of 1957, 55th Legislature of Texas, Regular Session, as amended (collectively, the "District Act").
Official Action:	Resolution Authorizing the Issuance, Sale and Delivery of Tarrant Regional Water District, a Water Control and Improvement District, Water Transmission Facilities Contract Revenue Bonds (City of Dallas Project), Series 2015, dated _____, 2015.
Purpose:	The Obligations are being issued for the purpose of (i) pay for design, acquisition, and construction costs related to the Dallas Project Component (as defined in the Contract) of the Project, (ii) fund a reserve fund for the Series 2015 Bonds, and (iii) pay costs of issuance of the Series 2015 Bonds.
Security for the Obligations:	See "SECTION___ PLEDGE" OF "APPENDIX B – FORM OF OFFICIAL ACTION."
Ratings:	See "OTHER INFORMATION - Ratings"
Delivery Date:	_____, 2015.

See "APPENDIX A - MATURITY SCHEDULE" for Principal Amounts,

Maturities, Interest Rates, Prices or Yields, and Initial CUSIP Numbers

TARRANT REGIONAL WATER DISTRICT
A WATER CONTROL AND IMPROVEMENT DISTRICT

BOARD OF DIRECTORS

Victor W. Henderson ..... President

Jack R. Stevens ..... Vice President

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James W. Lane. ..... Secretary Pro Tem

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BOKF, NA dba Bank of Texas, Paying Agent/Registrar

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relating to

$140,000,000

TARRANT REGIONAL WATER DISTRICT, A WATER CONTROL AND IMPROVEMENT DISTRICT, WATER TRANSMISSION FACILITIES CONTRACT REVENUE BONDS (CITY OF DALLAS PROJECT), SERIES 2015

INTRODUCTION

This Private Placement Memorandum, including the cover page and appendices, contains brief descriptions of the Issuer, provides certain information with respect to the issuance by the Issuer, and summaries of certain provisions of the "Obligations" pursuant to the Official Action. Except as otherwise set forth herein, capitalized terms used but not defined in this Private Placement Memorandum have the meanings assigned to them in the Official Action. See "APPENDIX B – "FORM OF OFFICIAL ACTION" attached hereto.

APPENDIX A contains the maturity schedule for the Obligations. APPENDIX B contains the Official Action and a description of the purpose for the proceeds of the Obligations. APPENDIX C contains a copy of the proposed opinion of Bond Counsel with respect to the Obligations. The summaries of the documents contained in the forepart of this Private Placement Memorandum are not complete or definitive, and every statement made in this Private Placement Memorandum concerning any provision of any document is qualified by reference to such document in its entirety.

THE OBLIGATIONS

General Description

The Obligations are being issued in the aggregate principal amount set forth in APPENDIX A of this Private Placement Memorandum and will mature and be subject to redemption prior to maturity as described therein. The Obligations are being issued as fully registered bonds in denominations of $5,000**,** or any integral multiple thereof. The Obligations will be dated as of the stated date of issue and will mature on the dates referenced thereon, and will bear interest at the rates per annum set forth in "APPENDIX A - MATURITY SCHEDULE."

Interest on the Obligations is payable semiannually on each Interest Payment Date, and will be calculated on the basis of a 360-day year consisting of twelve 30-day months. Principal of and the redemption price with respect to the Obligations will be payable to the Owners upon presentation and surrender at the principal office of the Paying Agent/Registrar.

Purpose

See "APPENDIX B - FORM OF OFFICIAL ACTION."

Authority for Issuance

The Obligations are issued pursuant to the general laws of the State of Texas, including Chapters 49 and 51, Texas Water Code, as amended, and pursuant to the District Act and pursuant to the Official Action.

Security for the Obligations

See "APPENDIX B - FORM OF OFFICIAL ACTION."

Redemption Provisions

On September 1, 2026, or on any date thereafter, the Obligations maturing on and after March 1, 2026 may be redeemed prior to their scheduled maturities, upon the written direction of the Issuer, with funds provided by the Issuer, at par plus accrued interest to the date fixed for redemption as a whole, or in part, and if less than all of a maturity is to be redeemed the Paying Agent/Registrar will determine by lot the Obligations, or portions thereof within such maturity to be redeemed (provided that a portion of a Bond may be redeemed only in Authorized Denominations).

Notice of Redemption; Selection of Obligations to Be Redeemed

See "APPENDIX B - FORM OF OFFICIAL ACTION."

The Paying Agent/Registrar, so long as a Book-Entry-Only System is used for the Bonds, will send any notice of redemption of the Bonds, notice of any proposed amendment to the Official Action or other notices with respect to the Bonds only to DTC. Any failure by DTC to advise any DTC Participant (defined below), or of any DTC participant to notify the beneficial owner, shall not affect the validity of the redemption of the Bonds called for redemption or any other action premised on any such notice. Redemption of portions of the Bonds by the Issuer will reduce the outstanding principal amount of such Bonds held by DTC.

Book-Entry-Only System

The information in this caption concerning The Depository Trust Company, New York, New York ("DTC") and DTC's book entry system has been obtained from DTC and the Issuer makes no representation or warranty nor takes any responsibility for the accuracy or completeness of such information.

DTC will act as securities depository for the Obligations. The Obligations will be issued as fully-registered securities registered in the name of Cede & Co. (DTC's partnership nominee) or such other name as may be requested by an authorized representative of DTC. One fully-registered certificate will be issued for each maturity of the Obligations and deposited with DTC. See APPENDIX B - "FORM OF OFFICIAL ACTION."

DTC is a limited-purpose trust company organized under the New York Banking Law, a "banking organization" within the meaning of the New York Banking Law, a member of the Federal Reserve System, a "clearing corporation" within the meaning of the New York Uniform Commercial Code, and a "clearing agency" registered pursuant to the provisions of Section 17A of the Securities Exchange Act of 1934. DTC holds and provides asset servicing for over 3.5 million issues of U.S. and non-U.S. equity, corporate and municipal debt issues, and money market instrument (from over 100 countries) that DTC's participants (the "Direct Participants") deposit with DTC. DTC also facilitates the post-trade settlement among Direct Participants of sales and other securities transactions, in deposited securities, through electronic computerized book entry transfers and pledges between Direct Participants' accounts. This eliminates the need for physical movement of securities certificates. Direct Participants include both U.S. and non-U.S. securities brokers and dealers, banks, trust companies, clearing corporations, and certain other organizations. DTC is a wholly-owned subsidiary of The Depository Trust & Clearing Corporation ("DTCC"). DTCC is the holding company for DTC, National Securities Clearance Corporation, and Fixed Income Clearance Corporation, all of which are registered clearing agencies. DTCC is owned by the users of its regulated subsidiaries. Access to the DTC system is also available to others such as both U.S. and non-U.S. securities brokers and dealers, banks, trust companies, and clearing corporations that clear through or maintain a custodial relationship with a Direct Participant, either directly or indirectly ("Indirect Participants"). Direct Participants and Indirect Participants are referred to herein collectively as "Participants". DTC has a Standard & Poor's rating of "AA+". The DTC Rules applicable to its Participants are on file with the Securities and Exchange Commission. More information about DTC can be found at www.dtcc.com and www.dtc.org.

Purchases of Obligations under the DTC system must be made by or through Direct Participants, which will receive a credit for the Obligations on DTC's records. The ownership interest of each actual purchaser of each Bond ("Beneficial Owner") is in turn to be recorded on the Participants' records. Beneficial Owners will not receive written confirmation from DTC of their purchase. Beneficial Owners are, however, expected to receive written confirmations providing details of the transaction, as well as periodic statements of their holdings, from the Participant through which the Beneficial Owner entered into the transaction.

Transfers of ownership interests in the Obligations are to be accomplished by entries made on the books of Participants acting on behalf of Beneficial Owners. Beneficial Owners will not receive Obligations representing their ownership interests in Obligations, except in the event that use of the book-entry system for the Obligations is discontinued.

To facilitate subsequent transfers, all Obligations deposited by Direct Participants with DTC are registered in the name of DTC's partnership nominee, Cede & Co., or such other name as may be requested by an authorized representative of DTC. The deposit of Obligations with DTC and their registration in the name of Cede & Co. or such other DTC nominee do not effect any change in beneficial ownership. DTC has no knowledge of the actual Beneficial Owners of the Obligations; DTC's records reflect only the identity of the Direct Participants to whose

accounts such Obligations are credited, which may or may not be the Beneficial Owners. The Participants will remain responsible for keeping account of their holdings on behalf of their customers.

Conveyance of notices and other communications by DTC to Direct Participants, by Direct Participants to Indirect Participants, and by Direct Participants and Indirect Participants to Beneficial Owners will be governed by arrangements among them, subject to any statutory or regulatory requirements as may be in effect from time to time.

Redemption notices shall be sent to DTC. If less than all of the Obligations within a maturity are being redeemed, DTC's practice is to determine by lot the amount of the interest of each Direct Participant in such maturity to be redeemed.

Neither DTC nor Cede & Co. (nor any other DTC nominee) will consent or vote with respect to Obligations unless authorized by a Direct Participant in accordance with DTC's Money Market Instrument Procedures. Under its usual procedures, DTC mails an Omnibus Proxy to the Issuer as soon as possible after the record date. The Omnibus Proxy assigns Cede & Co.'s consenting or voting rights to those Direct Participants to whose accounts Obligations are credited on the record date (identified in a listing attached to the Omnibus Proxy).

All payments on the Obligations will be made to Cede & Co., or such other nominee as may be requested by an authorized representative of DTC. DTC's practice is to credit Direct Participants' accounts upon DTC's receipt of funds and corresponding detail information from the Issuer or the Paying Agent/Registrar, on payable date in accordance with their respective holdings shown on DTC's records. Payments by Participants to Beneficial Owners will be governed by standing instructions and customary practices, as is the case with Obligations held for the accounts of customers in bearer form or registered in "street name," and will be the responsibility of such Participant and not of DTC, the Paying Agent/Registrar, or the Issuer, subject to any statutory or regulatory requirements as may be in effect from time to time. All payments to Cede & Co. (or such other nominee as may be requested by an authorized representative of DTC) are the responsibility of the Issuer or the Paying Agent/Registrar, disbursement of such payments to Direct Participants will be the responsibility of DTC, and disbursement of such payments to the Beneficial Owners will be the responsibility of Participants.

DTC may discontinue providing its services as depository with respect to the Obligations at any time by giving reasonable notice to the Issuer or the Paying Agent/Registrar. Under such circumstances, in the event that a successor depository is not obtained, Obligations are required to be printed and delivered.

With the consent of the Texas Water Development Board, the Issuer may decide to discontinue use of the system of book-entry-only transfers through DTC (or a successor securities depository). In that event, Obligations will be printed and delivered to DTC or successor securities depository.

TAX MATTERS

Opinion

Bond Counsel will deliver its opinion on the date of delivery of the Obligations substantially in the form as attached in "APPENDIX C - FORM OF OPINION OF BOND COUNSEL."

OTHER INFORMATION

Forward Looking Statements

The statements contained in this Private Placement Memorandum, including the cover page, appendices, and any other information or documents provided by the Issuer, that are not purely historical, are forward-looking statements, including statements regarding the Issuer's assumptions, expectations, hopes, intentions, or strategies regarding the future. Any of such assumptions, expectations or hopes could be inaccurate and, therefore, there can be no assurance that the forward-looking statements included herein will prove to be accurate. Holders of the Bonds should not place undue reliance on forward-looking statements. All forward-looking statements included in this Private Placement Memorandum are based on information available to the Issuer on the date hereof, and the Issuer assumes no obligation to update any such forward-looking statements. It is important to note that the Issuer's actual results could differ materially from those in such forward-looking statements.

Ratings

The existing outstanding City of Dallas (the "City") contract revenue bonds are rated "AAA" by Standard & Poor's Ratings Services, a Standard & Poor's Financial Services LLC business, and "Aa1" by Moody's Investors Service, Inc. An explanation of the significance of such ratings may be obtained from the company furnishing the rating. The ratings reflect only the respective views of such rating companies, and the District makes no representation as to the appropriateness of the ratings. There is no assurance that such ratings will continue for any given period of time, or that they will not be revised downward or withdrawn entirely by either or both of such rating companies, if in the judgment of either or both companies, circumstances so warrant. Any such downward revision or withdrawal of such ratings, by either of them, may have an adverse effect on the market price of the Obligations. **No application has been made to any rating agency or municipal bond insurance company for qualification of the Obligations for ratings or municipal bond insurance, respectively.**

LITIGATION

There is no litigation, proceeding, inquiry, or investigation pending by or before any court or other governmental authority or entity (or, to the best knowledge of the Issuer, threatened) that adversely affects the power, authority or obligation of the Issuer to deliver the Bonds, the security for, or the validity of, the Bonds or the financial condition of the Issuer. On the date of initial delivery of Bonds, the Issuer will execute and deliver a certificate of like effect to the purchaser of the Bonds.

CONTINUING DISCLOSURE OF INFORMATION

In the Official Action, the Issuer has made the following agreement for the benefit of the holders and beneficial owners of the Obligations. The City is required to observe the agreement for so long as it remains obligated to advance funds to pay the Obligations. Under the agreement, the Issuer will be obligated to provide certain updated financial information and operating data, and timely notice of specified material events, to certain other information vendors. SEE APPENDIX B - "FORM OF OFFICIAL ACTION."

Compliance with Prior Undertakings

During the last five years, the City believes it has complied in all material respects with all continuing disclosure agreements made by it in accordance with the Rule. During the time when the City was unable to timely prepare its audited financial statements, in order to comply with the Rule, the City filed unaudited financial information for the fiscal years in question, and promptly filed audited financial statements once available.

MISCELLANEOUS

Any statements made in this Private Placement Memorandum involving matters of opinion or of estimates, whether or not so expressly stated, are set forth as such and not as representations of fact, and no representation is made that any of the estimates will be realized. Neither this Private Placement Memorandum nor any statement that may have been made verbally or in writing is to be construed as a contract with the owners of the Obligations.

The information contained above is neither guaranteed as to accuracy or completeness nor to be construed as a representation by the Issuer. The information and expressions of opinion herein are subject to change without notice and neither the delivery of this Private Placement Memorandum nor any sale made hereunder is to create, under any circumstances, any implication that there has been no change in the affairs of the Issuer or the Issuer from the date hereof.

The Private Placement Memorandum is submitted in connection with the sale of the securities referred to herein and may not be reproduced or used, as a whole or in part, for any other purpose.

ADDITIONAL INFORMATION

The Private Placement Memorandum speaks only as of its date and the information contained herein is subject to change. Descriptions of the Obligations and the Official Action and any other agreements and documents contained herein constitute summaries of certain provisions thereof and do not purport to be complete.

APPENDIX A

MATURITY SCHEDULE **CUSIP Prefix: 876448** [(1)]
(Due September 1)

Amount	Maturity September 1,	Rate	Yield	CUSIP Suffix	Amount	Maturity September 1,	Rate	Yield	CUSIP Suffix
$3,360,000	2017				$4,695,000	2032			
3,395,000	2018				4,845,000	2033			
3,440,000	2019				5,005,000	2034			
3,495,000	2020				5,170,000	2035			
3,550,000	2021				5,345,000	2036			
3,620,000	2022				5,530,000	2037			
3,690,000	2023				5,725,000	2038			
3,770,000	2024				5,925,000	2039			
3,855,000	2025				6,130,000	2040			
3,950,000	2026				6,340,000	2041			
4,050,000	2027				6,570,000	2042			
4,165,000	2028				6,800,000	2043			
4,285,000	2029				7,040,000	2044			
4,415,000	2030				7,290,000	2045			
4,550,000	2031								

(1) CUSIP is a registered trademark of the American Bankers Association. CUSIP data is provided by CUSIP Global Services, managed by Standard & Poor's Financial Services LLC on behalf of the American Bankers Association. This data is not intended to create a database and does not serve in any way as a substitute for the CUSIP services. Neither the Issuer nor the Co-Financial Advisors take any responsibility for the accuracy of CUSIP numbers.

APPENDIX B

FORM OF OFFICIAL ACTION

APPENDIX C

FORM OF OPINION OF BOND COUNSEL