dallas water utilities

Recycled Water Implementation Plan Volume I

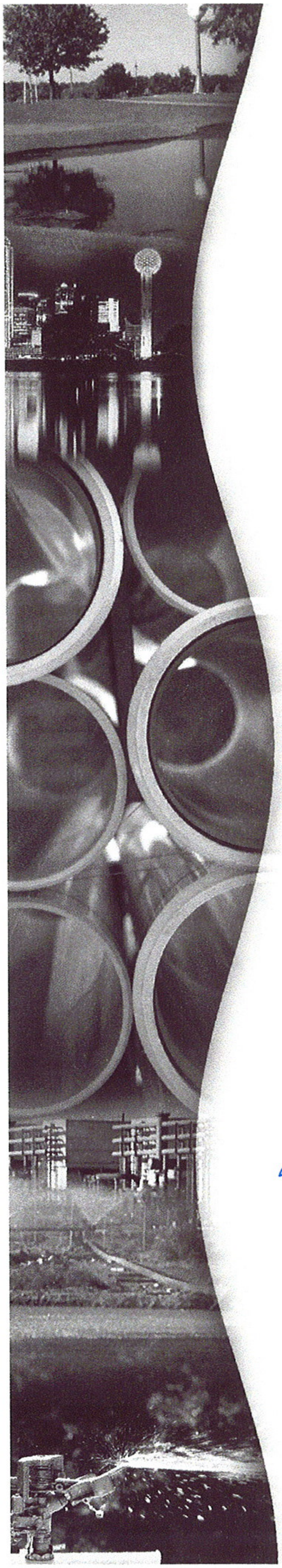
DWU Contract 03-110E
APAI Project 356-0701

August 30, 2005
Final Report

submitted by:

ALAN PLUMMER ASSOCIATES, INC.
ENVIRONMENTAL ENGINEERS - DESIGNERS - SCIENTISTS

CP&Y



dallas water utilities

Recycled Water Implementation Plan Volume I

STATE OF TEXAS
BETTY L. JORDAN
63546
REGISTERED
PROFESSIONAL ENGINEER

DWU Contract 03-110E
APAI Project 356-0701

STATE OF TEXAS
ALISTAIR A. TEES
64858
REGISTERED
PROFESSIONAL ENGINEER

August 30, 2005
Final Report

8/29/05

STATE OF TEXAS
EDWARD M. MOTLEY
48243
REGISTERED
PROFESSIONAL ENGINEER

submitted by:

ALAN PLUMMER ASSOCIATES, INC.
ENVIRONMENTAL ENGINEERS - DESIGNERS - SCIENTISTS

CP&Y

dallas water utilities
City of Dallas

August 30, 2005

Ms. Virginia Sabia
Contract Manager
Texas Water Development Board, Room 469
1700 North Congress Avenue
Austin, Texas 78711-3231

Re: Dallas Water Utilities
Recycled Water Implementation Plan, Vol. 1
TWDB Contract 2003-483-486

Dear Ms. Sabia:

Dallas Water Utilities (DWU) is pleased to submit the following items:

1. Nine bound, double-sided copies of the *Recycled Water Implementation Plan, Volume* I, *Final Report, August 30, 2005*, printed on recycled paper.
2. One unbound, single-sided, camera-ready copy of the *Recycled Water Implementation Plan, Volume* I, *Final Report, August 30, 2005.*
3. One electronic, PDF format copy of the *Recycled Water Implementation Plan, Volume* I, *Final Report, August 30, 2005.*
4. A copy of the TWDB's review comments dated June 30, 2005, and written responses to those comments follows this letter.

This report provides a summary of the evaluation methodology and recommended alternative for direct, non-potable recycling of highly treated effluent produced by DWU's wastewater treatment plants. The project was funded in part by a grant from the Texas Water Development Board, TWDB Contract 2003-483-486.

For your information, Volume 2 of the *Recycled Water Implementation Plan* will describe a subsequent effort to evaluate alternatives for indirect recycling of DWU effluent. However, this work was not performed using TWDB funding and, therefore, is not included as part of this submission.

Please do not hesitate to contact me, Mr. Dan Nolen, or Ms. Betty Jordan with any questions regarding the content of this report.

Thank you for your support and input on this project.

Sincerely,

Donna Long

Donna Long, P.E., Program Manager
Wastewater Facilities Project Management
Dallas Water Utilities
Enclosures (4)

cc: Ms. Betty Jordan, Alan Plummer Associates, Inc.
Mr. Dan Nolen, Dallas Water Utilities

June 30, 2005

Ms. Donna Long, P. E.
Program Manager
Dallas Water Utilities
2121 Main Street, Suite 300
Dallas, TX 75201

Re: Regional Water Supply Facility (Reclaimed Water Implementation Plan) Grant Contract Between the City of Dallas (CITY) and the Texas Water Development Board (BOARD), TWDB Contract No. 2003-483-486, Draft Final Report Review

Dear Ms. Long:

Staff members of the Texas Water Development Board have completed a review of the draft report under TWDB Contract No. 2003-483-486. As stated in the above-referenced contract, the CONTRACTOR(S) will consider incorporating comments from the EXECUTIVE ADMINISTRATOR as shown in Attachment 1 and other commentors on the draft final report into a final report. The CONTRACTOR(S) will include a copy of the EXECUTIVE ADMINISTRATOR's comments in the final report.

The Board looks forward to receiving one (1) electronic copy, one (1) unbound single-sided camera-ready original, and nine (9) bound double-sided copies of the final report on this study.

If you have any questions concerning this contract, please contact Ms. Virginia Sabia Towles, the Board's designated Contract Manager for this study, at (512) 475-2056.

Sincerely,

William F. Mullican, III
Deputy Executive Administrator
Office of Planning

Attachment

c: Virginia Sabia Towles, TWDB

ATTACHMENT 1

TEXAS WATER DEVELOPMENT BOARD
Review Comments of the Draft Final Report entitled
"Dallas Water Utilities, Recycled Water Implementation Plan"
Contract No. 2003-483-486

Draft Final Report Review Comments

1 Please include a definition of "water factory" in the Executive Summary or Chapter I. This term is used frequently but not defined until well into the report.

2 Page 2-14 - Section 2.4, 4th paragraph, the report should clarify that the seven tasks referenced for the regional water planning cycle completed in 2001 were required at that time. Subsequent tasks have been added for the current regional water planning cycle.

3 Page 2-17 - The Population and Water Demand Projections discussion reflects the projections from the 2001 Region C Water Plan. Please note in report that these projections have been updated for the 2006 Region C Water Plan based on data from the 2000 census.

4 Page 3-4 - Under Section 3.2.4, the report includes a statement, "Sufficient raw water conveyance is available to meet the projected demands and could support additional supply provided by recycled water." The report should describe how this would occur and the implications of such a policy. Specifically, are some existing conveyances proposed to be converted to use for recycled water?

5 Pages 5-3 and 5-5 & 5-19 and 5-21 - Both y and x axis's on the two sets of 3 graphs on pages 5-3 and 5-5 (as well as those sets on pages 5-19 and 5-21) appear nearly identical yet the data points are different (e.g. CBOD points). Please label both sets of graphs and clarify the difference between graphs and data points.

6 Page 5-23 - The report lists examples of the types of water uses appropriate for recycled water. Table 8-2 lists major water users, including customer types. It would be useful to combine aspects of both by listing potential uses for recycled water for different customer types. For example, what are the potential uses of recycled water for service industries, office buildings, hotels, etc.?

7 Page 8-2, Table 8-1 - labeled as 'Largest 100 Water Customers' has only 50 customers listed. The Scope of Work, Task 7, states that the top 100 water users will be identified. Please rectify.

8 Chapter 10, Table 10-1 - It is unclear from the labels what the unit 'capital costs' mean. Please indicate whether the capital costs ($/1000G) is the capital cost per plant (*MGD) capacity* or the long-term capital costs divided by the actual volume of throughput.

9 Chapter 10 – The report would benefit from inclusion of the basis for Capital Costs presented in Table 10-1. Including an appendix with the spreadsheets for project cost components would be useful to current and future report readers.

10 Chapter 10 - Tables 10-3 and 10-5 give average long-term costs per 1000 gallons but do not provide discounted unit costs of water for comparing plants over their lifetimes. Present value unit costs of water, taking into account both capital and operating costs and their disparate impact on

overall costs, would assist consumers of the report to better judge the relative cost-effectiveness between plants.

(11) Page 10-5 - "Advantage" #3 regarding the power costs of Water Factories appears to be a net disadvantage. Consider rewording for clarity or placing this item along with the other "Disadvantages of water factories..." on page10-6.

(12) Table 10-5 and 10-6 - The terminology in Table 10-5 refers to costs for a "Total Recommended System" and Table 10-6 references the same system as "Recommended Recycled System" and a second system as "Total Recycled Water System." Please edit for consistency and clarity.

(13) Page 10-6 - The "Disadvantage" #3 does not appear to be a disadvantage of Water Factories as much as a requirement of any successful recycled water program. If appropriate, suggest replacing the word "proper" with language such as "more extensive and costly."

(14) Page 10-8 – The report states that O&M costs would be 2.5 percent of capital costs. Please provide a reference to the source of this estimate. Also, please include information on the reasonableness of this assumption with regard to other similar plants.

(15) Page10-11 - The report should more fully explain the various 'credits' that may be realized from the use of recycled water.

(16) Appendix B, E, and F include draft documents intended for future use. Please include brief description pages in the appendices prior to these documents to clarify the future intent.

(17) The glossary of terms in Appendix C is extremely useful; however, it is not contained in the Table of Contents. Please rectify.

Texas Water Development Board
Review Comments of the Draft Final Report entitled
Dallas Water Utilities. Recycled Water Implementation Plan.
Contract No. 2003-483-486

1. Please include a definition of "water factory' in the Executive Summary or Chapter I. This term is used frequently but not defined until well into the report.

   Definition included incorporated into ES-5. A water factory is a strategically located wastewater treatment plant that intercepts wastewater from a specific area of the collection system, treats the after to standards appropriate for specific recycled water applications, and then delivers the effluent to end users within its geographical proximity

2. Page 2-14 – Section 2.4, 4th paragraph, the report should clarify that the seven tasks referenced for the regional water planning cycle completed in 2001 were required at that time. Subsequent tasks have been added for the current regional water planning cycle.

   Note added stating the above. The 2005 update of the Region C plan was not available, even in preliminary draft form when the Recycled Water Implementation Plan, draft report, May 2005, was completed.

3. Page 2-17 – The population and Water Demand Projections discussion reflects the projections from the 2001 Region C Water Plan. Please note in report that these projections have been updated for the 2006 Region C Water Plan based on data from the 2000 census.

   Note included in Section 2.4 indicating that population projections have been updated. TWDB November 2003 population projections were used to estimate water demands and wastewater availability for the Recycled Water Implementation Plan.

4. Page 3—4 – Under Section 3.2.4, the report includes a statement, "Sufficient raw water conveyance is available to meet the projected demands and could support additional supply provided by recycled water." The report should describe hwo this would occur and the implications of such a policy. Specifically, are some existing conveyances proposed to be converted to use for recycled water?

   Sentence added to clarify that the use of the pipelines to convey additional raw water supplies such as recycled water projects involved recycled water used to augment raw water supplies. There is no plan at this time to change the use of pipelines from raw water conveyance to recycled water conveyance.

5. Pages 5-3 and 5-5 & 5-19 and 5 –21 – Both y and x axis's on the two sets of 3 graphs on pages 5-3 and 5-5 (as well as those sets on pages 5-19 and 5-21) appear nearly identical yet the data points are different (e.g., CBOD points). Please label both sets of graphs and clarify the difference between graphs and data points.

   The scales and data are the same. They appear different because of differences in reduction for reproduction of the report. The second set of graphs is the same as the first set of graphs except that the existing and projected permit limits for each constituent *are added to show the historical quality relative to these two sets of standards. Missing figure numbers and titles were supplied.*

6. Page 5-23. The report lists examples of the types of water uses appropriate for recycled water. Table 8-2 lists major water users, including customer types. It would be useful to combine aspects of both by listing potential users for recycled water for different customer types. For example, what are the potential uses of recycled water for service industries, office buildings, hotels, etc.?

   The following table was added to Chapter 5, Section 5.5 – Potential Recycled Water Uses.

Potential Recycled Water End User Categories	***Potential Uses of Recycled Water***
Manufacturing	Process water, landscape irrigation, cooling water, dust control
Hospitals	Cooling water, landscape irrigation
Food Production	Indirect irrigation of food crops that will be peeled, skinned, cooked, or thermally processed
Residential	Landscape irrigation, toilet flushing
Irrigation	Irrigation of animal feed crops other than pastures for milking animals, sod farms
Service Industry	Irrigation of parks, golf courses, maintenance of restricted recreation impoundments, silviculture, highway medians, raw water augmentation
Hotels	Cooling water, landscape irrigation
Power Generation	Cooling water
Office Buildings	Cooling water, landscape irrigation
Construction	Dust control, soil compaction

7. Page 8-2, Table 8-1 – labeled as "Largest 100 Water Customers' has only 50customers listed. The Scope of Work, Task 7, states that the top 100 water users will be identified. Please rectify.

   Second page of table inadvertently omitted.

8. Chapter 10, Table 10-1 – It is unclear from the labels what the unit 'capital costs' mean. Please indicate whether the capital costs ($/1000G) is the capital cost per plant (MGD) capacity or the long-term capital costs divided by the actual volume of throughput.

   Under the column "Capital Costs," the first column shows the total capital cost for the plant and/or pipeline listed. The second column shows the total capital cost divided by the supply volume. Headings have been changed to reflect this difference.

9. Chapter 10 – The report would benefit from inclusion of the basis for Capital Costs presented in Table 10-1. Including an appendix with the spreadsheets for project cost components would be useful to current and future report readers.

   Spreadsheets showing basis of calculations are included as Appendix G.

10. Chapter 10 – Tables 10-3 and 10-5 give average long-term costs per 1000 gallons but do not provide discounted unit costs of water for comparing plants over their lifetimes. Present value unit costs of water, taking into account both capital and operating costs and their disparate impact on overall costs, would assist consumers of the report to better judge the relative cost-effectiveness between plants.

    The last two columns of each table show a present value of the projects over 30 and 50 years based on building the projects now. These values were used for comparison purposes. The phasing of specific elements of the proposed projects is still being refined. The implementation schedule will be subject to refinement based on customer interest and commitment toward recycled water and on funding availability.

11. Page 10-5 – "Advantage" #3 regarding the power costs of Water Factories appears to be a net disadvantage. Consider rewording for clarity or placing this item along with the other "Disadvantages of water factories..." on page 10-6.

    Advantages and disadvantages reworked. As presented originally, Advantage #3 was a disadvantage.

12. Table 10-5 and 10-6 – The terminology in Table 10-5 refers to costs for a "Total Recommended System" and Table 10-6 references the same system as "Recommended Recycled System" and a second system as "Total Recycled Water System." Please edit for consistency and clarity.

    Edit addressed.

13. Page 10-6 – The "Disadvantage" #3 does not appear to be a disadvantage of Water Factories as much as a requirement of any successful recycled water program. If appropriate, suggest replacing the word "proper" with language such as "more extensive and costly."

    Edit addressed. Advantages and disadvantages reworked. Agree that siting issues exist for any new wastewater, water factory, or reuse project. However, here, the issue is a new water factory as opposed to an existing wastewater treatment plant that has already dealt with the siting issues.

14. Page 10-8 – The report states that O&M costs would be 2.5 percent of capital costs. Please provide a reference to the source of this estimate. Also, please include information on the reasonableness of this assumption with regard to other similar plants.

    The O&M Costs estimated at 2.5% of the capital costs was the standard adopted for both the Region C Plan and the DWU Long Range Water Supply Plan for facilitie such as pump stations.

15. Page 10-11 – The report should more fully explain the various "credits" that may be realized from the use of recycled water.

Section 10.4 expanded with additional details on the "benefits" that may be realized from the use of recycled water. The term "credits" was misleading.

16. Appendix B, E, and F include draft documents intended for future use. Please include brief description pages in the appendices prior to these documents to clarify the future intent.

    Introductory material added.

17. The glossary of terms in Appendix C is extremely useful; however, it is not contained in the Table of Contents. Please rectify.

    Reference in Table of Contents added.

Attn: Betty Jordan w/ Alan Plummer

On August 29, 2005 Reprographics Fort Worth, Inc. printed the Final Report Proposal using Georgia Pacific High Performance recycled office paper that contains 30% post-consumer recycled fiber.

2220 West Peter Smith Fort Worth, TX 76102 Phone: 817-332-9704 Fax: 817-335-7855

TABLE OF CONTENTS

TABLE OF CONTENTS
(continued)

TABLE OF CONTENTS
(continued)

TABLE OF CONTENTS
(continued)

TABLE OF CONTENTS
(continued)

TABLE OF CONTENTS
(continued)

TABLE OF CONTENTS
(continued)

LIST OF TABLES

LIST OF TABLES
(continued)

LIST OF TABLES
(continued)

LIST OF FIGURES

EXECUTIVE SUMMARY

As the populations of Texas's major metropolitan areas continue to grow at unprecedented rates, water resource needs demand increasingly more attention and creative approaches. It is estimated that the demand for water in Dallas will exceed its currently authorized supplies around 2025. For decades, the City of Dallas has worked and continues to work to develop additional resources in order to continue to provide its citizens and industries with a reliable supply of safe water. Dallas, along with many other cities throughout the country, is looking closely at opportunities to use highly treated effluent or recycled water to augment other sources of water in meeting water demands.

In the fall of 2003, a team led by Alan Plummer Associates, Inc. (APAI) was authorized by the Dallas Water Utilities Department (DWU) to develop a Recycled Water Implementation Plan. This project was supported by the Texas Water Development Board (TWDB) through TWDB Contract No. 2003-483-486 with the DWU. The APAI team included Baker Consulting; Chiang, Patel & Yerby, Inc. (CP&Y); Read, Stowe &. Yanke, LLC; and consultants Dr. James Crook, Ph.D, P.E, and Mr. Joseph Towry. The project involved evaluating two different options for the use of recycled water – direct, nonpotable reuse and indirect potable reuse through the augmentation of raw water supplies. The nonpotable use options are addressed here, in Volume 1 of the Recycled Water Implementation Plan. The raw water augmentation options are addressed in Volume 2 and are only briefly described in this document.

ES.1 The Need for Additional Water Sources/The Role of Recycled Water

DWU currently has water rights to a firm yield of 598 MGD (based on 2010 estimates of firm yield in the March 2005 Draft Long Range Water Supply Plan Update) from Lake Ray Roberts, Lake Lewisville, Grapevine Lake, Lake Ray Hubbard, Lake Tawakoni, Lake Palestine, and Lake Fork. The firm yield of a reservoir is defined as the quantity of water that can be withdrawn from the reservoir such that at the end of a long-term drought (seven years), the conservation storage is fully depleted. Figure ES-1 shows the locations of the existing water supply reservoirs and the DWU water and wastewater treatment plants. While not currently connected to the DWU system, construction is underway to meet the current schedule to provide Lake Fork water to DWU by 2007. Total water demand during normal weather with conservation efforts is projected to increase from approximately 529 MGD in 2010 to approximately 847 MGD in 2060. Based on current estimates, including at least 5 percent reduction in per capita demand as a result of conservation, it is estimated that the demand for water will exceed the available, firm supply by about 2012. In addition to the supplies currently online or soon to go online, DWU has water rights to approximately 102 MGD in Lake Palestine. A pipeline would have to be constructed from the reservoir to Dallas to make the water available. Lake Palestine is currently scheduled to go online in 2015.

DWU is faced with the development of additional water supplies within the next two decades to continue to meet the demands of its service area. Two potential applications of recycled water are being evaluated to assist DWU in meeting water demands. The first is the direct nonpotable reuse of the current effluent in lieu of providing for some existing potable water demands. The second is indirect potable reuse in which more highly treated effluent would be recycled into

(This page intentionally left blank.).

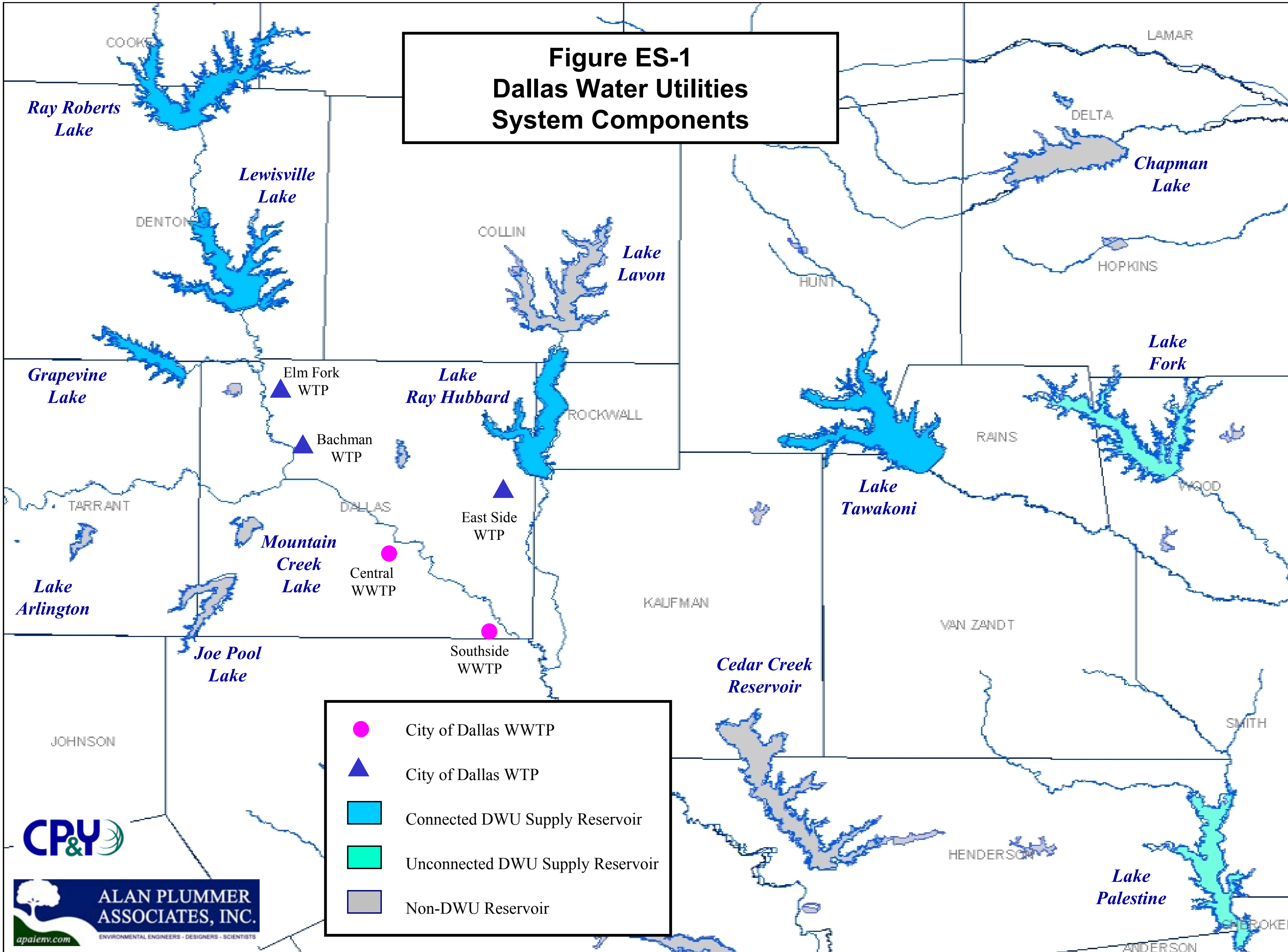


Figure ES-1
Dallas Water Utilities
System Components

(This page was intentionally left blank.)

DWU's water supply reservoirs to augment other surface water supplies. Both applications defer the need to develop other, more expensive and difficult to obtain water supplies. Direct nonpotable reuse is discussed further below. Indirect potable reuse is addressed in Volume 2 of this report.

ES.2 Suitability of DWU Wastewater Treatment Plant Effluent for Recycling

There are two types of nonpotable reuse practiced in Texas – Type I for which there is a high probability of contact with the public and which, therefore, requires more stringent water quality, and Type II for which public access is controlled and thus does not require the stringent water quality of Type I. An example of Type I reuse would be irrigation of a school's landscaping or athletic fields. An example of Type II reuse would be irrigation of a golf course. Over ten years of historical effluent data from both the Central and Southside WWTPs were reviewed along with several months of special testing related to reuse–specific parameters to determine whether the effluents currently discharged from the treatment plants were appropriate for reuse or whether additional treatment would be required. Based on the review, the effluents from both plants consistently meet the Type II criteria and, except for rare excursions, meet the Type I criteria. The initial phase of the recycled water implementation program focused on the Type II applications.

ES.3 Potential Projects

The City of Dallas is already involved in a recycled water project with the construction of a system to transport highly treated effluent from the Central WWTP to the City's Cedar Crest Golf Course for irrigation. In the current project, a study was conducted to identify the largest water usage customers within the City and then to pair them with potential sources of wastewater (e.g., potential use volumes vs. generated volumes within close geographic areas). The idea was to identify areas in which it made sense either to serve the potential customers with recycled water from one of the existing plants (Central or Southside) or to construct a small water factory or treatment plant within the area of generation and demand. A water factory is a strategically located wastewater treatment plant that intercepts wastewater flows from a specific area of the collection system, treats the water to standards appropriate for specific recycled water applications, and then delivers the effluent to end users within its geographical proximity. Four potential recycled water service areas were identified. One of the areas, White Rock, was further divided into two areas to evaluate the use of water factories.

1. Cedar Crest Corridor Service Area
2. Lower White Rock Service Area
3. Upper White Rock Service Area
4. Love Field Service Area
5. Southwest Dallas Service Area

The service areas are shown on Figure ES-2 along with the potential projects. Details of the development of these service areas are discussed in Chapter 9. The potential projects within each of these service areas are outlined below.

(This page was intentionally left blank.)

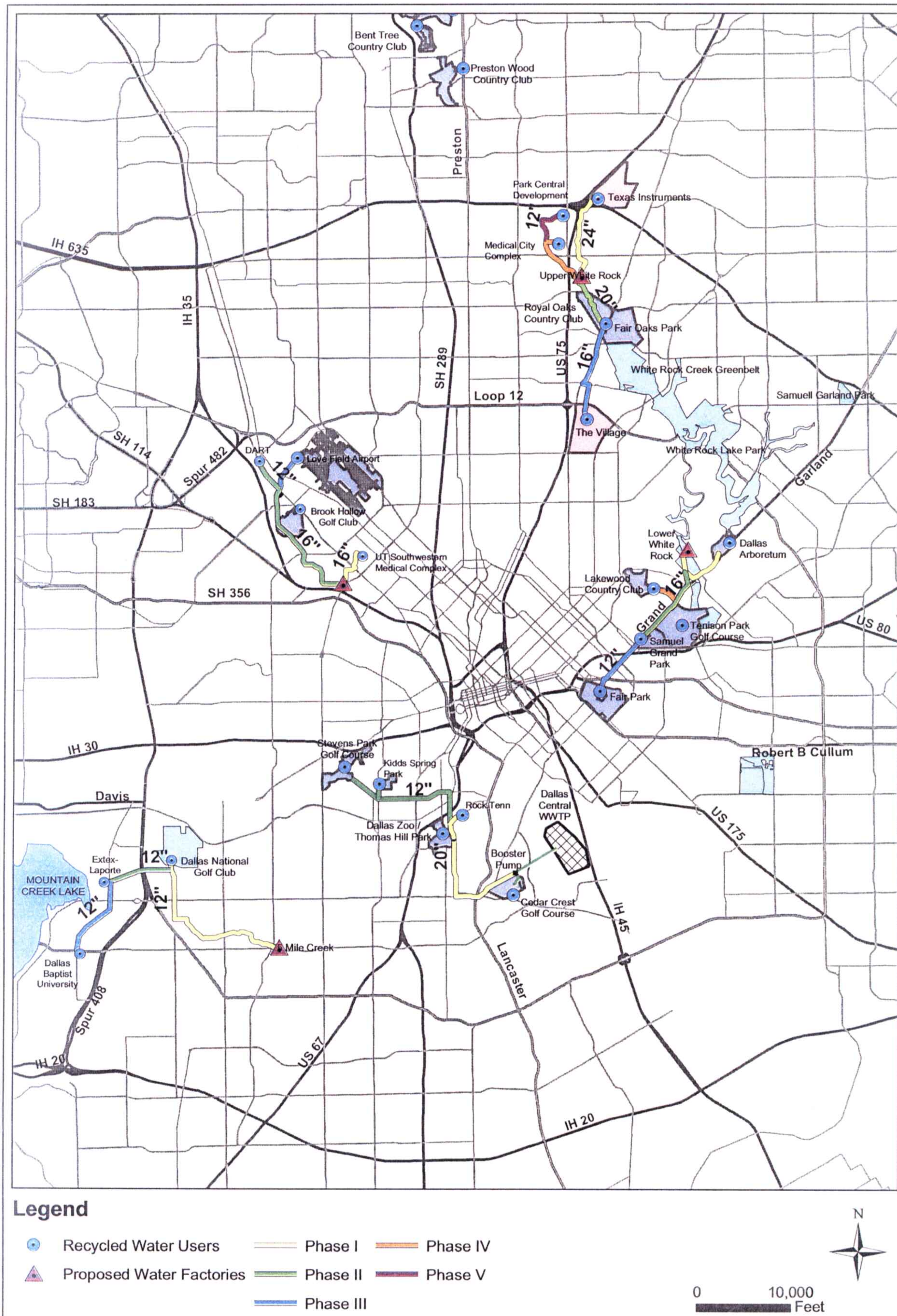


FIGURE ES-2

DALLAS WATER UTILITIES
RECYCLED WATER IMPLEMENTATION PLAN
OVERALL SYSTEM

(This page was intentionally left blank.)

Cedar Crest Pipeline Extension:

Phase I: Extend the existing pipeline to the Dallas Zoo and Rock Tenn area
Phase II: Extend pipeline to Stevens Park Golf Course and Kidds Springs Park

White Rock Pipeline from the Central WWTP

A pipeline could be constructed in the White Rock Creek basin from the Central WWTP northward to Texas Instruments, continuing on to north Dallas. This alternative would have the advantage of eliminating the need for the two water factories in the Upper and Lower White Rock systems (described below) but would require two pump stations to pump recycled water from the Central WWTP to customers in the White Rock Basin. As an alternative to the pipeline from Central WWTP, a separate system could be developed around water factories in the Upper and Lower White Rock Service Areas.

Lower White Rock System Alternate:

Phase I: 5.0-MGD water factory and pipeline to the Arboretum
Phase II: Pipeline to Samuel Grand Park and Tenison Park Golf Course
Phase III: Pipeline to Fair Park
Phase IV: Pipeline to Lakewood Country Club

Upper White Rock System Alternate:

Phase I: 15-MGD water factory and pipeline to Texas Instruments
Phase II: Pipeline to Fair Oaks Park and Royal Oaks Country Club
Phase III: Pipeline to the Village Apartment complex
Phase IV: Pipeline to the Medical City Complex
Phase V: Pipeline to the Park Central Development area

Love Field System:

Phase I: 4.5-MGD water factory and pipeline to the Medical Complex area
Phase II: Pipeline to the DART facility located on Harry Hines
Phase III: Pipeline to Love Field Airport

Southwest Dallas System:

Phase I: 5.0-MGD water factory pipeline to Dallas National Golf Club area
Phase II: Pipeline to the Extex-Laporte area
Phase III: Pipeline to Dallas Baptist University area

ES.4 Project Feasibility and Recommended Projects for Implementation

A conceptual-level feasibility analysis was performed for each of the recycle projects and phases. This analysis included estimating capital costs, operations and maintenance costs, and energy costs for each of the projects and phases. Based on the feasibility analysis of the potential projects, two projects were identified as viable projects to further develop the DWU recycled water program.

Table ES-1 identifies the projects that are recommended for further consideration in the near term, including an estimate of the potential volume of recycled water that could be used by customers initially identified, followed by a projected volume based on extension of the original delivery systems or on bringing other customers online. These flow projections are followed by a recommended capacity for the proposed delivery systems. The delivery capacity exceeds the projected supply needs to allow for growth of the customer base demand. Several cities have found that once recycled water is available, the demand for it increases significantly. The final three columns show estimates of the capital, operations and maintenance, and energy costs.

TABLE ES-1
RECYCLED WATER PROJECT RECOMMENDED FOR FURTHER DEVELOPMENT

Project	Identified Average Usage	Projected Average Supply	Delivery System Capacity	Capital Costs	O & M Costs	Energy Costs
	(MGD)	(MGD)	(MGD)	($MM)	Annual	Annual
Cedar Crest Pipeline Extend pipeline to Zoo, Rock-Tenn Area	1.74	1.75	3.50	$ 6.50	$ 162,500	$ 60,168
White Rock Pipeline Alternative	7.37	16.50	30.00	$55.20	$1,380,000	$825,159
Total Recommended System	9.11	18.25	33.50	$61.70	$1,542,500	$885,327

The recommended systems involve two projects with a potential direct, nonpotable reuse quantity of nearly 20 MGD. The use of recycled water in these applications does not eliminate the need to develop other water supplies, but it does defer the need to expand existing treatment facilities and bring additional water supplies online for as much as three years.

ES.5 Moving Forward – Further Implementing DWU's Recycled Water Program

DWU has already embarked on implementing a recycled water program with its Cedar Crest Golf Course Project. Further implementation of recycled water projects should involve the following actions.

- Develop policies and procedures to provide an orderly, safe protocol for the design, construction, and operation of recycled water projects.

- Incorporate the recycled water function into the DWU's existing utility structure. It is recommended that the function initially be organized under a Program Manager in the Water Utility because other cities have found that the sale of recycled water from a water utility is more successful than the sale of water from a wastewater utility. Incorporating the function under the water utility does not ignore the role that the wastewater utility plays in producing the valuable product being sold. Figure ES-3 illustrates how a recycled water program involves several departments within a city.

Incorporating Recycle Water Operations into Existing DWU Operations

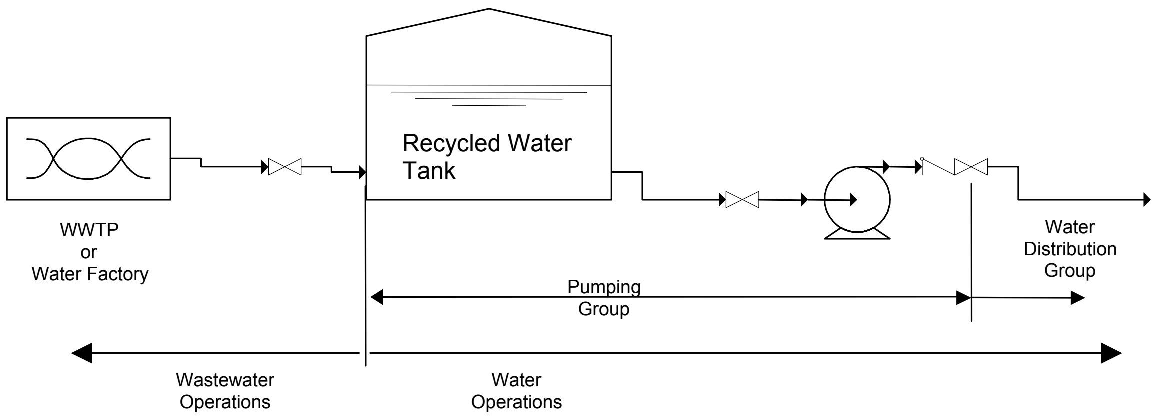


FIGURE ES-3

Incorporating Recycled Water Operations and Existing DWU Operations

- Update the City's recycled water ordinance to better reflect the City's current position of encouraging recycled water projects and use. Elements to be addressed should include, at a minimum, the following considerations:

  - Setting the recycled water rate at 75 to 80 percent of the potable water rate,
  - Restricting the sales of raw water in the targeted recycled water service areas and contesting term water rights permits,
  - Financing recycled water projects as alternative water supply projects,
  - Modifying cross-connection policies to address the specific issues associated with recycled water projects, and
  - Allowing the recycled water operations group the ability to enforce rules and regulations.

  It is important to develop and enforce the codes associated with the development of recycled water projects to ensure the safety of the public and encourage the appropriate use of recycled water.

- Prepare and submit a Chapter 210 Water Reclamation Notification to TCEQ that covers the potential reuse projects.

- Develop a Public Information/Public Awareness campaign regarding recycled water. Public involvement and buy-in to recycled water projects is critical to success.

- Operate and analyze the Cedar Crest Golf Course pilot project recycled water supply operations, expanding the project to include additional customers.

- Implement selected recycled water projects as identified in this report.

- Perform marketing analysis of potential recycled water customers to expand projects.

- Develop a DWU and User Contract.

A schedule for implementation is presented in Table ES-2 and Figure ES-4. The implementation schedule will be subject to refinement based on customer interest and commitment toward recycled water and on funding availability.

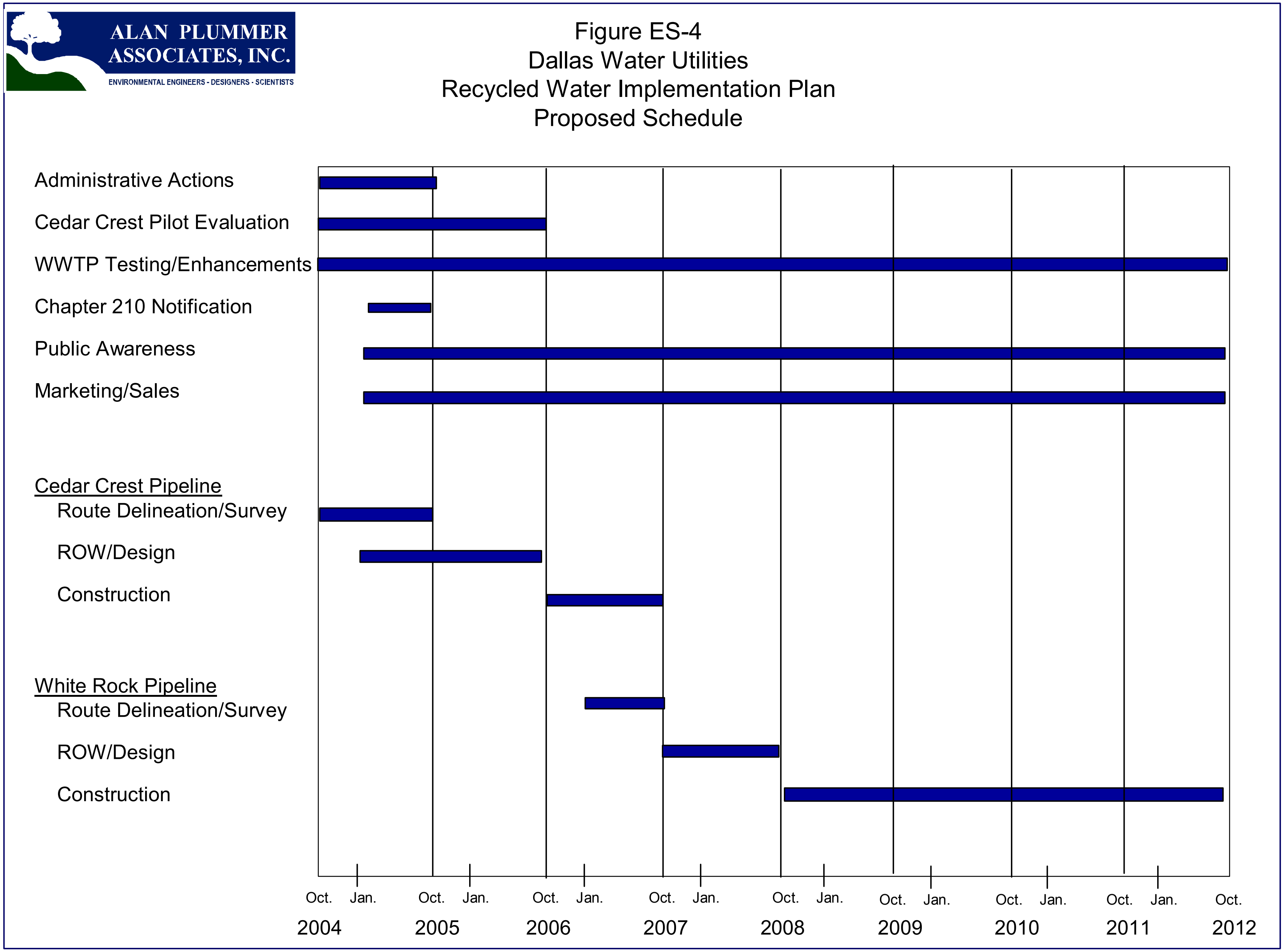
The implementation of the recommended recycled water projects will provide a dependable supply of water for the users. Additionally, it will be beneficial to the City of Dallas in extending the life of existing water supplies and water treatment and distribution infrastructure. Furthermore, it will serve as a major component of the City's water conservation strategic plan to reduce the daily per capita consumption of the City's customers. These projects represent an extension of the City's policy to be a good steward of the water resources.

TABLE ES-2
DALLAS WATER UTILITIES
RECYCLED WATER IMPLEMENTATION PLAN

FISCAL YEAR 2004 (not shown in Figure ES-4)
☐ Develop Recycled Water Implementation Plan. ☐ Monitor and evaluate operation of Cedar Crest golf course pilot recycled water project. ☐ Continue wastewater treatment plant testing of additional parameters.
FISCAL YEAR 2005
☐ Perform Administrative Actions o Initiate actions to establish recycled water organizational structure. o Develop and adopt policies and procedures. o Update City ordinances (i.e., rates, financial provisions. o Develop and adopt recycled water standard contract. ☐ Perform Cedar Crest Pilot Evaluation. ☐ Continue wastewater treatment plant testing of additional parameters. Based on monitoring results, initiate operations enhancement program, if necessary. ☐ Revise Chapter 210 Notification. ☐ Initiate Public and Water Customer Recycled Water Awareness Program. ☐ Initiate recycled water marketing and sales activities. ☐ Finalize routing delineation and surveying for Cedar Crest pipeline extension. ☐ Begin right-of-way acquisition and design for Cedar Crest pipeline extension.
FISCAL YEAR 2006
☐ Perform Cedar Crest Pilot Evaluation. ☐ Continue wastewater treatment plant testing of additional parameters. ☐ Continue Public and Water Customer Recycled Water Awareness Program. ☐ Continue recycled water marketing and sales activities. ☐ Continue design for Cedar Crest pipeline extension.
FISCAL YEAR 2007
☐ Continue wastewater treatment plant testing of additional parameters. ☐ Continue Public and Water Customer Recycled Water Awareness Program. ☐ Continue recycled water marketing and sales activities. ☐ Construct Cedar Crest pipeline extension. ☐ Perform routing delineation and surveying for White Rock Creek corridor pipeline.
FISCAL YEAR 2008
☐ Continue wastewater treatment plant testing of additional parameters. ☐ Continue Public and Water Customer Recycled Water Awareness Program. ☐ Continue recycled water marketing and sales activities. ☐ Perform right-of-way acquisition and design for White Rock Creek corridor pipeline.
FISCAL YEARS 2009-2012
☐ Continue wastewater treatment plant testing of additional parameters. ☐ Continue Public and Water Customer Recycled Water Awareness Program. ☐ Continue recycled water marketing and sales activities. ☐ Initiate and complete phased construction of White Rock Creek corridor pipeline.

(This page was intentionally left blank.)

Figure ES-4
Dallas Water Utilities
Recycled Water Implementation Plan
Proposed Schedule



(This page was intentionally left blank.)

CHAPTER 1

INTRODUCTION

1.1 Background

Since 1881, the City of Dallas has worked and continues to work to develop water resources in order to provide its citizens and industries with a reliable supply of safe water, supporting healthy population and economic growth. Dallas, along with many other cities throughout the country, is looking closely at opportunities to use highly treated effluent or recycled water to replace and/or augment other sources of water in meeting water demands.

Recent long-range water supply planning efforts have identified significant needs for future water supplies. During the past several years, the peak demand on the potable water system has increased resulting in the need for water treatment plant expansions and improvements to both the raw water and potable water transmission systems. The City's commitment to using water in an efficient manner and the realization that new water supplies are difficult and expensive to obtain have encouraged DWU to seek creative solutions (e.g., water conservation, use of recycled water, etc.) for meeting the water needs of its customers. Therefore, augmentation of current water supply lakes with recycled water and a viable recycled water system are part of the long-range plan for Dallas.

As part of the regional planning efforts in Texas, the Texas Water Development Board (TWDB) has promoted and encouraged regions to increase water conservation. To help support the development of a recycled water implementation plan, DWU applied for and received a grant from the TWDB. The TWDB Regional Facility Planning Grant provided approximately half of the budget for the basic service tasks of this project. Additionally, DWU added and supported a number of special service tasks in the scope of work to supplement and further develop the implementation plan.

In the fall of 2003, a team led by Alan Plummer Associates, Inc. (APAI) was authorized by the City of Dallas Water Utilities Department (DWU) to develop a Recycled Water Implementation Plan. This project was supported by the Texas Water Development Board (TWBD) through TWDB Contract No. 2003-483-486 with the City of Dallas. The APAI team included Baker Consulting; Chiang, Patel & Yerby, Inc. (CP&Y); Read, Stowe & Yanke, LLC; and consultants Dr. James Crook, Ph.D, P.E.; and Mr. Joseph Towry. Dr. Crook is a nationally recognized leader in the field of reclaimed water and served as one of the editors of the EPA Water Reuse Guidance Document. Mr. Towry is Director of Utilities for St. Petersburg, Florida, where a large reclaimed water system including dual water supplies for residential customers was constructed and continues to grow.

The project involves evaluating two different options for the use of recycled water – direct, nonpotable reuse and indirect potable reuse through the augmentation of raw water supplies. The nonpotable use options are addressed in this volume (Volume 1) of the report. The raw water augmentation options are addressed in Volume 2 and are described only briefly in this document.

1.2 Project Scope

The goals of this project were to develop an implementation plan identifying appropriate uses for highly treated effluent from City of Dallas's Southside and Central wastewater treatment plants and/or from new water factories, and to develop the conceptual plans for several reclaimed water projects that could be constructed and put into service in the near future. Dallas is committed to conserving water and views nonpotable reuse as a significant element in its plan to conserve.

The scope of the project included the following items either for review or to generate options to be used as parameters in the feasibility analysis to develop reuse plan recommendations:

- Review previous DWU reports or studies regarding reclaimed water.
- Review reclaimed water quality regulations at both the state and national levels.
- Evaluate the Central and Southside WWTPs' effluent quality relative to potential recycled water project requirements.
- Review population and flow forecasts.
- Develop a list of potential recycled water customers based on water use records.
- Review the roles of public perception and education in recycled water projects.
- Develop a public information program to support the recycled water implementation plan.
- Identify potential recycled water uses/options.
- Identify service areas, demands, and potential locations for recycled water projects.
- Conceptualize potential projects and develop list of alternatives.
- Perform feasibility analysis on the list of alternatives and identify most viable projects.
- Identify code, regulatory, and administrative infrastructure needed to support a recycled water utility within the DWU operations organizational structure.
- Develop a recycled water plan including recommended projects and infrastructure needs.

Initially, the project included only minimal evaluation of utilizing recycled water to augment raw water supplies. However, during the course of the project, the City of Dallas became more interested in the potential for augmenting raw water supplies with recycled water and expanded the scope to include a more extensive investigation of raw water augmentation. Augmentation will be briefly discussed in this volume (Volume 1) of the report and addressed in detail in Volume 2. At the same time that the City is developing this recycled water implementation plan, it is also looking very carefully at ways to conserve water. DWU's Water Conservation Public Awareness Program is being coordinated with the development of the recycled water implementation plan to ensure a unified focus on the overall approach to good stewardship of the water resources available to Dallas. The results of the water conservation project will be incorporated into a Five-Year Strategic Plan for Water Conservation.

The project objectives were achieved by reviewing previous studies, meetings and workshops with DWU staff, assessing current and future water needs, and diagnostic tasks carried out by the project team to develop viable projects. These potential projects were then analyzed based on engineering and economic feasibility to define the recommended reuse options.

1.3 Organization of Report

This report is generally organized by the major tasks in the scope of work for this project. An executive summary precedes the main body of the report. Following the current introductory chapter, the remaining chapters of the report address the topics listed below:

Chapter 2:	Historical water reuse studies.
Chapter 3:	Water demands, supplies, and needs.
Chapter 4:	Reclaimed water standards and regulations at the state and national level.
Chapter 5:	Suitability of current Central and Southside WWTPs' effluents relative to recycled water project requirements.
Chapter 6:	Examples of state and national recycled water projects.
Chapter 7:	Public perceptions and public relations impacts on the success of recycled water projects.
Chapter 8:	Potential recycled water customers.
Chapter 9:	Recycled water service areas and potential projects.
Chapter 10:	Project feasibility and recommendations for implementation.
Chapter 11:	Recycled water program organizational structure.
Chapter 12:	Regulations, policies, and recycled water pricing.
Chapter 13:	Recommended implementation plan.

(This page intentionally left blank.).

CHAPTER 2

DWU HISTORICAL REUSE PROGRAM EVALUATIONS

2.1 Introduction

Utilizing recycled water to supplement potable water supplies has been evaluated by Dallas periodically over the past two decades. The City is in the process of constructing its first recycled water project - delivery of Central WWTP effluent to the City's Cedar Crest Golf Course. The following documents record the history of recycled water studies for the DWU service area and form the foundation for the current plan development.

- Reclaimed Water Study, CH2M Hill, et. al., August 1993.
- Draft 2005 Update - Long Range Water Supply Plan, Chiang, Patel & Yerby, Inc., March 2005.
- Region C Regional Water Supply Plan (Senate Bill 1)
- DWU Water Rights Permit Application
- Texas Commission on Environmental Quality (TCEQ) Water Rights Permits Applications by major water providers in Texas.

The scope and findings of each of these studies are briefly described below.

2.2 Reclaimed Water Study, August 1993

As part of its permit renewal in October 1991, the City of Dallas performed a reclaimed water study. CH2M Hill, et al., were authorized by the City of Dallas to conduct a Major Interceptor Study and Wastewater Master Plan Update for Dallas Water Utilities (DWU). One part of this project was a reclaimed water study, since the TCEQ [formerly Texas Water Commission (TWC)] required that such a study be completed concurrent with the renewal of all TWC wastewater discharge permits.

A major focus of the Reclaimed Water Study was to determine if the use of highly treated wastewater effluent in lieu of potable water for non-potable needs was a cost-effective alternative to developing new water sources and/or raw water conveyance systems. DWU's goals were to implement recycled water projects where practical and cost-effective and to implement a planning program for future recycled water projects.

The scope of the Reclaimed Water Study included the following components:

- Assessment of water supply and demand.
- Identification of potential areas for recycled water use.
- Identification/inventory of potential uses/options for recycled water.
- Analysis of feasible recycled water options.
- Identification of project constraints and benefits of implementation.
- Conceptual engineering of selected recycled water options.
- Identification of implementation and funding options.

The study report also documented that DWU was already using recycled water as a potable water supply, since at the time over 13 percent of the dependable yield of DWU water rights was WWTP effluent discharged by upstream water users. DWU considered these return flows to be an integral part of its future water supply and predicted that the percentage would increase to more than 16 percent by 2050.

Eleven potential recycled water projects were identified and evaluated of which three were selected for further study, development of conceptual design, and evaluation of feasibility. Four of the eleven projects included potable water supply augmentation, since potable water supply augmentation can be an effective option for delaying the need for developing new water supply sources. However, none of these augmentation projects were selected for further study because of the high capital costs of pipelines and additional water treatment facilities required. The three recycled water projects selected for further development included:

- Cedar Crest Corridor, including providing recycled water to Rock-Tenn, the Dallas Zoo, and the Cedar Crest Golf Course with treated effluent from the Central WWTP.

  Note: DWU is now proceeding with a portion of this project by supplying recycled water to the Cedar Crest Golf Course for irrigation.

- Love Field Corridor, which included a new "water factory" at the existing Bachman Stormwater Overflow Treatment Plant and supplying industrial customers in the Love Field/Harry Hines area in two phases.

- Far South Dallas/Red Bird Corridor, which included a new "water factory" that would supply a wide variety of customers in South Dallas and be implemented in three phases. Table 2-1 shows the peak and average recycled water demands for these three projects.

TABLE 2-1
RECYCLED WATER DEMAND, 1993 RECLAIMED WATER STUDY

Recycled Water Project	Phase	Estimated Avg. Recycled Water Demand (MGD)	Assumed Peak Recycled Water Demand (MGD)
Cedar Crest Corridor	**Total**	**0.68**	**2.72**
Love Field Corridor	Phase 1	0.31	1.24
	Phase 2	0.12	0.48
	Total	**0.43**	**1.72**
South Dallas/Red Bird Corridor	Phase 1	0.25	1.00
	Phase 2	0.13	0.52
	Phase 3	0.23	0.90
	Total	**0.61**	**2.44**

The proposed water factories would have to meet water quality standards requiring advanced secondary treatment, similar to the level of treatment provided by the Central and Southside WWTPs. No biosolids processing facilities would be required since the solids would be returned to the sewer interceptor to be transported to the Central WWTP for processing.

Several issues were identified that have an impact on the probable success of a recycled water project including:

- Public Acceptance
- Project Economics
- Water Rights
- Institutional/Regulatory Requirements
- Environmental Impacts

Public Acceptance

Based on a review of other recycled water programs, public acceptance of recycled water projects was deemed to be critical to their success. The study also considered the perceived attitude of Dallas citizens toward conservation and environmental issues. The study concluded that recycled water used for industrial process water would be considered more favorably by the public than a recycled water project that returns the treated water to the water supply source (supply augmentation).

From a review of recycled water programs, the study recommended the following to enhance the public acceptance of DWU's recycled water program:

- Initially do <u>not</u> include projects with direct or indirect potable water use.
- Involve public information committees.
- Communicate how the recycled water program works and why it is environmentally desirable.
- Implement projects gradually.
- Clearly indicate that the use of recycled water is not a substitute for conservation.
- Educate decision makers and the public as to the economics of water supply and the role recycled water can play in preserving the environment.

Project Economics

The study recognized that recycled water can be a valuable and marketable commodity; and, as such, pricing and promotion are critical to market development. Chapter 49, Section 18.5, of the Dallas City Code has rules for funding recycled water projects and for pricing the recycled water. The code requires all users to pay for all capital costs for distribution and sets the price for recycled water at 50 percent of the price of raw water. These rules will likely prevent the implementation of most recycled water projects.

DWU would initially have to subsidize the recycled water system and pay for capacity beyond that required for the initial customers to allow for future system expansion. The existing City Code would need to be modified to allow for these subsidies.

A pricing strategy should consider a combination of direct costs and some recovery of lost revenue from potable water sales. DWU should also consider creating zones where use of recycled water is required and perhaps require certain users to locate only in these zones.

The costs (capital, annual, and unit) were estimated for the three developed projects as presented in Table 2-2.

TABLE 2-2
RECYCLED PROJECT COSTS, 1993 RECLAIMED WATER STUDY

Recycled Water Project	Phase	Capital Costs ($MM)	Annual Costs ($MM) [d]	Est. Recycled Water Costs ($/1000 gal)
Cedar Crest Corridor	Complete Project [b]	2.163	0.258	1.05
Love Field Corridor	Phase 1	4.412	0.583	5.15
	Complete Project [b]	6.353	0.785	5.00
South Dallas/Red Bird Corridor	Phase 1	5.128	0.687	7.53
	Phase 2 [c]	2.562	0.957	6.90
	Complete Project [b]	10.983	1.319	5.92

Notes:
(a) All costs are in 1993 dollars.
(b) Complete project capital and annual costs are stand-alone and assume entire project was completed without phasing.
(c) Phase 2 capital costs are the costs to expand the facilities. Phase 2 annual cost are for Phase 1 and Phase 2 combined.
(d) Annual costs include debt service, operating and maintenance costs, and power costs.
(e) Equipment life assumed to be 20 years
(f) Power cost was based on $0.07/kWhr
(g) The 20-year interest rate for bond revenues was assumed to be 7 percent.

Water Rights

The study acknowledged that the impact of recycled water use on water rights had not been clearly defined by the TWC, the legislature, or the courts. However, three key issues were identified that were likely to affect recycled water in the Dallas area:

- **Ownership of Effluent/Recycled Water**. Right of use remains with DWU as long as its use conforms to DWU's water rights permit and the water is controlled by DWU, i.e., maintained in pipes, tanks or constructed channels.

- **Transfer of Recycled Water to Other Watersheds**. DWU has permits to transfer water between river basins in some of its water rights agreements, but this authority needs to be investigated.

- **Return-to-Stream-Flow Requirements**. In 1993, DWU was not required to return effluent to the stream as long as the water was being devoted to municipal users. This issue may have to be defended if downstream water users become adversely affected by flow reductions.

Institutional/Regulatory Requirements

The study identified regulatory factors that may impact a recycled water project to include water rights agreements, Texas Water Commission (TWC now TCEQ) regulations, City ordinances, stormwater and wastewater discharge permit requirements from EPA and the TWC, and regulations in customer cities. The TWC adopted new Texas Administrative Code (TAC), Chapter 210 (now Chapter 210), "Use of Reclaimed Water," in 1990.

Environmental Impacts

The study determined that the net environmental effects of a recycled water program are positive. Such a program would reduce loadings on the Trinity River and reduce overall demand on the water supplies. No public health dangers were identified for use of recycled water under the conditions required by TWC regulations. Application of recycled water with the quality as proposed in the projects identified had been shown to be safe in other areas of the country. A monitoring program would be required to protect public health and safety.

Benefits and Constraints Summary

Table 2-3 summarizes the benefits and constraints identified in the 1993 Reclaimed Water Study.

Recommendations and Insights Related to Recycled Water from Reclaimed Water Study

The major conclusions of the 1993 Reclaimed Water Study were:

- According to the study, there are historically two drivers that make recycled water use cost-effective:

  - Insufficient water supply
  - A need to remove wastewater effluent from the receiving body of water

Unless one of these factors is present, it is generally less expensive to use a conventional potable water supply and treatment facilities for all water needs than to develop a recycled water system. At the conclusion of the Study in 1993, DWU was found to have neither of the above driving forces.

- Providing recycled water was not a cost-effective method of supplementing potable water supplies and/or postponing DWU's planned water and wastewater capital improvements at that time.

- DWU should analyze recycled water projects as part of its ongoing water and wastewater systems planning.

TABLE 2-3
BENEFITS AND CONSTRAINTS OF RECYCLED WATER USE BY DWU
(FROM 1993 RECLAIMED WATER STUDY)

Benefits	Constraints
1. Demand on area lakes is reduced; the supply of water is increased. 2. Reducing raw water demand, especially peak demand, enhances water conservation goals. 3. Water recycling is an environmentally desirable use of effluent. 4. TWC permit renewal requirements are satisfied. 5. Water recycling is an additional environmentally acceptable “tool” for water resources. 6. Total discharges and loadings on the Trinity River are reduced. 7. A secondary source of water of appropriate quality for urban irrigation and many industrial process applications is provided. 8. Water to which DWU already has rights is more fully used to benefit DWU customers. 9. Water factories would reduce load on the Central WWTP. 10. Costly water treatment capital improvements could be postponed.	1. The City of Dallas has adequate water supplies through the year 2035; recycled water is not an indispensable source of supply. 2. Public acceptance of recycled water for urban irrigation could be clouded by the perception that it is primarily a disposal method and potential source of pollution. 3. Selling recycled water at a lower price in lieu of potable water will reduce potable water revenues. 4. Major water users are widely dispersed. 5. Growth patterns and locations of existing WWTPs typically require long and costly recycled water conveyance system. 6. No major potential recycled water user. 7. Texas’s anti-degradation policy may limit economically feasible discharge to area lakes.

However, the study recognized the following:

- Additional water supplies will likely be much more expensive to develop than they were in the past.
- Recycled water may become a cost-effective alternative to developing new supplies.
- WWTP effluent quality requirements are likely to become more stringent.
- In the future, it may become more cost-effective to recycle effluent than to treat it to required levels.

In light of the above information, the study recommended the following in relation to the future use of recycled water:

- Install dual distribution systems during construction in areas targeted for recycled water use.
- Develop a public information program that effectively communicates the benefits of recycled water use.
- Develop a pricing structure that effectively recovers the costs of providing recycled water.
- Re-evaluate the use of recycled water every five (5) years, concurrent with the TWC permit renewal application.

2.3 Draft 2005 Update – Long Range Water Supply Plan (March 2005)

The Draft 2005 Update - Long Range Water Supply Plan (LRWSP) projects the water supply needs and available supply through 2060. This draft version of the update was completed in March 2005 by Chiang, Patel & Yerby, Inc. and includes recommendations provided by this report and Volume 2 of the Recycled Water Implementation Plan (related to indirect recycling). The issues addressed in this update are similar to those addressed in the previous 1989 and 2000 Plan, and similar procedures were generally followed. The following summarizes the Plan Update with emphasis on recycled water issues.

The City of Dallas has been a leader in planning for future water supply in the North Texas area. The Plan Update was developed concurrently with Texas Water Development Board's Regional Water Plan efforts, including Region C, of which DWU is a part. The update was coordinated with Region C's population and water demand projection efforts as well as water supply issues.

The Plan Update included the following chapters:

- Planning and Service Area
- Population Projections
- Water Demand Projections
- Water Rights and Reservoir Yields

- Water Supply Alternatives
- Evaluation of Water Supply Alternatives
- Future Water Supply Recommendations
- Existing Water Treatment Plant Capacity
- Future Water Treatment Plant Capacity
- Existing Raw Water Conveyance Capacity
- Future Raw Water System Improvements

The following paragraphs detail the scope and findings of the Draft 2005 LRWSP Update.

Planning and Service Area

As of 2005, DWU served 21 treated water and 6 raw water customers in Dallas, Denton, Collin, Kaufman, Ellis, and Tarrant Counties. The recommended planning and service area was the same as per the 2000 Supply Plan, except as follows:

- The City of Grapevine was added as a raw water customer.
- Red Oak, Rockett SUD, and Ellis County WCID #1 were added as treated water customers in Ellis County.
- Johnson County SUD was added as a potential customer.

Population Projections

Historical and projected population data were gathered and reviewed for the current and potential use cities and regions, including data from:

- Texas Water Development Board (TWDB)
- North Central Texas Council of Governments (NCTCOG)
- Dallas Water Utilities (DWU)
- Current and potential customer cities
- U.S. Bureau of the Census

Table 2-4 is a summary of the population forecast for the Total DWU Planning and Service Area:

TABLE 2-4
POPULATION PROJECTIONS
2005 DRAFT LRWSP UPDATE

Year	Population
2000	2,247,189
2010	2,770,001
2020	3,245,802
2050	4,253,734

As the March 2005 Draft Long Range Water Supply Plan population projections were not available at the time this study was performed, the November 2003 TWDB projections were used for the calculation of available recycled water within the DWU service area. A detailed discussion of the population projections and methodology for calculation of wastewater flows is presented in Chapter 3.

The 2005 Draft LRWSP Update also included comparisons of the various water supply projects and provided breakdowns for each city/region.

Water Demand Projections

The LRWSP Update team obtained and analyzed historical water demand data from the Pumping, Planning, and Wholesale Services Divisions of DWU. From these data, the team estimated the following:

- Per Capita Water Demand
- Effect of Conservation
- Average-Day Water Demand
- Peaking Factors
- Impact of Drought Conditions
- Peak-Day Demands

Table 2-5 is a summary of the water forecast for the Total Water Demand, including Dallas plus current and potential treated and raw water customers. All of these projections are for average-day demand under long-term drought conditions.

TABLE 2-5
WATER DEMAND PROJECTIONS
2005 DRAFT LRWSP UPDATE

Year	Water Demand (MGD)
2010	529
2020	606
2060	847

Existing Reservoir Yields

The City of Dallas uses, or has rights to, water from the following reservoirs:

Eastern System:

- Lake Ray Hubbard on the East Fork of the Trinity River near Rockwall, Texas
- Lake Tawakoni on the Sabine River south of Greenville, Texas

Western System:

- Ray Roberts Lake on the Elm Fork of the Trinity River north of Lewisville, Texas
- Lewisville Lake on the Elm Fork of the Trinity River near Lewisville, Texas
- Grapevine Lake on Denton Creek near Grapevine, Texas

Unconnected Reservoirs:

- Lake Palestine on the Neches River south of Tyler, Texas
- Lake Fork on Lake Fork Creek west of Quitman, Texas

Elevation-area-capacity data were gathered and adjusted for the impact of sedimentation through year 2060. Table 2-6 summarizes the projected water supply sources available:

TABLE 2-6
WATER SUPPLY PROJECTIONS
2005 DRAFT LRWSP UPDATE

Source	Dependable Supply Available to DWU [MGD]					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
Ray Roberts Lake/Lewisville Lake (1)	152.3	150.5	148.7	146.8	145.0	143.3
Grapevine Lake (2)	6.5	6.1	5.7	5.3	4.9	4.5
Lake Ray Hubbard	66.3	66.3	66.3	66.3	66.3	66.3
Lake Tawakoni	163.9	162.7	161.5	160.3	159.0	157.8
Lake Fork (3)	107.0	107.0	107.0	107.0	107.0	107.0
Lake Palestine (3)	102.0	101.1	100.2	99.3	98.4	97.6
Reservoir Subtotal	**598.0**	**593.7**	**589.4**	**585.0**	**580.6**	**576.5**
Other Sources (4)						
CF75 (5)	10.0	10.0	10.0	10.0	10.0	10.0
Permit 5414	8.9	8.9	8.9	8.9	8.9	8.9
Return Flows (6)	30.7	39.9	47.4	54.1	62.3	71.0
Non-Reservoir Subtotal	**49.6**	**58.8**	**66.3**	**73.0**	**81.2**	**89.9**
Total Supply	**647.6**	**652.5**	**655.7**	**658.0**	**661.8**	**666.4**

Notes: (1) DWU's share of Ray Roberts Lake's firm yield is 74.0 percent, and 95.18 percent of Lewisville Lake. The balance is controlled by the City of Denton.
(2) DWU's share of Grapevine Lake's firm yield is limited to 8.9 MGD per pending reservoir allocation plan.
(3) Lake Fork and Lake Palestine are not connected to DWU system.
(4) Elm Fork of the Trinity River exclusive of Ray Roberts Lake, Lewisville Lake, and Grapevine Lake
(5) Existing DWU CF75 permit allows for the use of 10.0 MGD of flow being added to the Trinity River below Lewisville Lake and Grapevine Lake.
(6) The supply shown is 40% of projected return flows to account for future unknowns in diversions and developments.

Water Rights

For the purposes of the existing water rights summary, the reservoirs comprising DWU's system are subdivided into the "western" and "eastern" systems that correspond to the existing water treatment system infrastructure, including the Elm Fork and Bachman Water Treatment Plants (western) and the East Side Water Treatment Plant (eastern).

Western Reservoirs:

- Ray Roberts Lake on the Elm Fork of the Trinity River (Trinity River Basin)
- Lewisville Lake on the Elm Fork of the Trinity River (Trinity River Basin) downstream of Ray Roberts Lake
- Grapevine Lake on Denton Creek, a tributary of the Elm Fork of the Trinity River (Trinity River Basin)

All three western reservoirs are multipurpose U.S. Army Corps of Engineers' (USACE) impoundments in which DWU holds water rights for water supply and storage. The annual diversion authorizations correspond to the original water supply storage capacity rather than their firm yields. This authority results in water rights that greatly exceed the firm (or dependable) yields that could be withdrawn during the drought of record. In addition to the reservoirs, DWU holds water rights for uncontrolled portions of the Elm Fork watershed.

Eastern Reservoirs:

- Lake Ray Hubbard on the East Fork of the Trinity River (Trinity River Basin)
- Lake Tawakoni on the Sabine River (Sabine River Basin)
- Lake Fork on Lake Fork Creek (Sabine River Basin)
- Lake Palestine of the Neches River (Neches River Basin)

Lake Fork Reservoir and Lake Palestine are not currently connected to the DWU system. DWU holds the water rights in Lake Ray Hubbard. The Sabine River Authority of Texas (SRA) holds the water rights for Lake Tawakoni and Lake Fork. The Upper Neches River Municipal Water Authority holds the Lake Palestine water rights. Water rights for the eastern reservoirs are based on the original firm yield estimates for these reservoirs.

Existing Raw Water Conveyance Capacity

DWU's raw water is supplied by reservoirs in the Trinity and Sabine River basins. Raw water from the western reservoirs is conveyed to the Bachman and Elm Fork water treatment plants by gravity through rivers and creeks, and then by pump stations at the plants. Raw water from the eastern reservoirs is pumped to the East Side Water Treatment Plant from pump stations located at the lakes. Table 2-7 summarizes the existing raw water conveyance capacities.

TABLE 2-7
RAW WATER CONVEYANCE CAPACITIES

Water Treatment Plant	Total Capacity (MGD)	Largest Pump (MGD)	Firm Capacity (MGD)
Western System			
Elm Fork WTP	376	38	338 (1)
Bachman WTP	200	40	160
Western System Subtotal	576	n/a	498 (1)
Eastern System			
East Side WTP			
Forney PS	352	58	200 (5)
Iron Bridge PS & Tawakoni Balancing Reservoir (4)	260 Pump 240 Grav	35	225
Eastern System Subtotal	460 (6)	n/a	440 (2)
DWU System Total (3)	**1036**	**n/a**	**938**

Source: March 2005 Draft Update Long Range Water Supply Plan

Notes:
(1) Total firm capacity equals the sum of individual capacities minus the largest pump in the group.
(2) For eastern system, the firm capacity is controlled by the water rights permit for Lake Ray Hubbard (limited to 200 MGD) plus the gravity capacity from the balancing reservoir (240 MGD).
(3) DWU overall system capacity equals sum of western and eastern systems.
(4) Iron Bridge PS capacities are based on 24-hour operation at full capacity (not time-of-day electrical metering).
(5) The Water Rights Permit for Lake Ray Hubbard limits diversion rates to 200 MGD.
(6) For eastern system, the total capacity is controlled by the water rights permit for Lake Ray Hubbard (limited to 200 MGD) plus the pumping capacity from the balancing reservoir.

Existing Water Treatment Capacity

At the time current construction projects are completed in the Spring of 2006, the three existing water treatment plants (WTPs), will have a net treatment capacity of 910 MGD. [Note: "Net" capacity is the capacity deliverable to the customers and includes about 10 percent of the treated water used for operation of the plant.] The treatment capacity is also dependent on the ability to move water from the WTP to the customer demands. Table 2-8 summarizes the WTP capacities.

TABLE 2-8
WATER TREATMENT PLANT CAPACITIES

Water Treatment Plant	Current Treatment Capacity (MGD)	Current Net Treatment Capacity (MGD)	Current Treated Water Firm Pumping Capacity (1) (MGD)	Historical Peak Pumping(2,3) (MGD)	Year 2005 Net Treatment Capacity(4) (MGD)	Year 2005 Treated Water Pumping Capacity(1,4) (MGD)
Elm Fork	330	320	310	291.9	320	310
Bachman	140 (2)	135	155	125.7	150	150
East Side	450	440	440	397.1	440	440
Total System	**920**	**895**	**885(1)**	**791.3**	**910**	**900**

Notes: (1) Listed capacity is firm high service pumping capacity assuming the largest pump is out of service. The total accounts for the minimum of pumping capacity and treatment capacity.
(2) Elm Fork's peak was 291.9 mgd, Bachman was 125.7 mgd, and East Side was 397.1 mgd.
(3) The historical peaks for each water treatment plant did not occur simultaneously. The historical peak for the system is 791.3 mgd.
(4) The Year 2005 Capacities are those which will be available given the completion of those contracts currently in progress for improvements at the treatment plants.

Future Water Supply Recommendations

The March 2005 Draft LRWSP Update summarizes the water supply needs, the water supply improvement alternatives, and evaluates different combinations of improvements. The Plan also evaluates water supply optimization strategies including water conservation, seasonal balancing, and cooperative projects with other regional water suppliers.

Ultimately, the following recommendations were developed:

Supporting Studies and Other Initiatives:

- Implement and fund Water Conservation Five Year Strategic Plan
- Develop a long-term water conservation plan
- Implement Recycled Water Implementation Plan recommendations related to institutional issues (organization, rate setting and marketing)
- Negotiate and execute contracts to secure return flows
- Participate in partnership with other Region C water providers in the Sulphur Basin Study
- Participate in Lake Fastrill studies

Capital Improvement Projects:

- Complete Lake Fork Project (2007)
- Complete Cedar Crest Direct Recycle Project (2010)
- Complete Tawakoni Pipeline Expansion Project (2012)
- Complete White Rock Direct Recycle Project (2012)
- Complete Ray Hubbard Recycled Water Project (2012)

- Complete Palestine Water Supply Project (2015)
- Complete Lewisville Recycled Water Project (2022)
- Connect a Sulphur River Basin water supply (2035)
- Connect an additional water supply project (either Lake Fastrill or Toledo Bend- 2045)
- Expand water treatment plants as required to support growing peak day demands

2.4 Region C Regional Water Supply Plan (Senate Bill 1)

In 1997, the 75th Texas Legislature passed Senate Bill 1, legislation designed to address Texas water issues. The legislature put in place a grass-roots regional planning process for the water needs of all Texans in the next century. The Texas Water Development Board (TWDB) created sixteen (16) regional water-planning groups and established regulations governing the regional planning efforts.

The Region C Regional Water Supply Plan, completed in January 2001, documented the results of the planning process for Region C, which covers all or part of 16 counties in North Central Texas. Region C includes all of Cooke, Grayson, Fannin, Jack, Wise, Denton, Collin, Parker, Tarrant, Dallas, Rockwall, Kaufman, Ellis, Navarro, and Freestone counties, and the part of Henderson County that is in the Trinity River Basin. All of the regional water plans in the state are currently being updated. These updated plans will be finalized early in 2006.

The Region C Water Planning Group hired a team of consultants to conduct technical analyses and prepare the regional water plan under the supervision of the planning group. This team included Freese and Nichols, Inc., Alan Plummer Associates, Inc., Chiang, Patel, and Yerby, Inc., and Cooksey Communications.

The TWDB planning guidelines require each regional water plan to include seven tasks as follows:

1. Description of Region C
2. Population and Water Demand Projections
3. Analysis of Water Supply Currently Available
4. Comparison of Current Water Supply and Projected Water Demand
5. Evaluation and Selection of Water Management Strategies
6. Regulatory, Legislative, Administrative, and Other Recommendations
7. Plan Approval Process and Public Participation

The scope and findings of the 2001 Region C Regional Water Supply Plan are described in the following paragraphs. [Note: For the 2005 update of the Region C plan, the number and description of the tasks were changed. The updated report was not available when the current summary was prepared. All of the population projections noted in this section have since been updated for inclusion in the 2006 Region C Water Plan.]

Description of Region C

As of 1998, the estimated population of Region C was 4,779,210, or 24.4 percent of Texas's total population. The most populous counties in Region C are Dallas and Tarrant that comprise 70.6 percent of the region's population. There are 38 cities in Region C with an estimated population of more than 20,000, and these cities comprise 80.5 percent of the Region's total population.

Economic Activity

Region C includes the Dallas–Fort Worth Metroplex, which experienced strong economic growth in the 1990s. Payroll and employment are concentrated in the central urban counties of Dallas and Tarrant with the largest business sectors being services and manufacturing.

Water-Related Physical Features

Most of Region C is in the upper portion of the Trinity Basin, with smaller parts in the Red, Brazos, Sulphur, and Sabine Basins. Precipitation and runoff increases from west to east, with rainfall of slightly more than 30 inches per year in western Jack County to more than 44 inches per year in the northeast corner of Fannin County.

There are thirty-four reservoirs in Region C with conservation storage of over 5,000 acre--feet. These reservoirs provide most of the region's water supply and are necessary to provide reliable surface water supply because of wide variations in natural streamflow.

Current Water Uses and Demand Centers

Water use in Region C has increased significantly since 1980, primarily due to increasing population and municipal demand. However, while Region C includes 24.4 percent of Texas's population, it used only 7.2 percent of the state's water, primarily because of the very limited use for irrigation. Municipal water supply accounts for 85 percent of the current water use, followed by manufacturing, and then steam electric power generation. Irrigation, mining, and livestock are relatively minor users of water.

Current Sources of Water Supply

Since 1990, over 90 percent of the water used in Region C has been supplied by surface water, mostly from reservoirs, but groundwater is still an important source of supply, especially in rural areas. However, the current use of groundwater exceeds the long-term supply available in many parts of Region C.

Over half of the water used for municipal supply is discharged as treated effluent from WWTPs, making treated wastewater recycling a potentially significant source of additional water supply. Many of the region's water suppliers are considering recycled water projects, and recycled water will be a significant part of future water planning for Region C.

Water Suppliers in Region C

Five major suppliers make up the bulk of the supply, as shown in Table 2-9. Cities and towns provide most of the retail water service in Region C.

TABLE 2-9
MAJOR WATER SUPPLIERS IN REGION C

Major Water Supplier	1997 Wholesale Sales [Acre-feet]			Number of Wholesale Customers		
	Raw	Treated	Total	Cities	Water Suppliers	Other
Tarrant Regional Water District	258,448	0	258,448	12	11	16
North Texas MWD	0	168,247	168,247	23	14	1
DWU	13,324	148,281	161,605	17	4	2
City of Fort Worth	427	39,521	39,948	28	2	4
Trinity River Authority	15,220	22,217	37,437	8	2	1

Agricultural and Natural Resources in Region C

Agricultural and natural resources in Region C are dependent on the region's water resources. The Texas Parks and Wildlife Department has identified several Region C stream segments as having significant natural resources based on their high water quality, exceptional aquatic life, high aesthetic value, fisheries, spawning areas, unique state holdings endangered or threatened species, priority bottomland hardwood habitat, wetlands, springs, and pristine areas.

Region C includes about 6,000,000 acres of farms and 2,500,000 acres of cropland, although less than 1 percent is irrigated. Oil and natural gas fields are significant resources in portions of Region C, and there are some lignite course resources.

Summary of Threats and Constraints to Water Supply in Region C

The most significant potential threats to existing water supplies are surface water quality, groundwater drawdown, and groundwater quality. Constraints on the development of new supplies include the availability of sites and unappropriated water for new reservoirs and the challenges imposed by environmental concerns and permitting.

Surface water quality concerns include:

- Detection of atrazine at low levels in some reservoirs
- Nutrient levels in reservoirs
- Total organic carbon (TOC) in source waters
- Elevated levels of dissolved solids in some reservoirs and streams
- Trace levels of arsenic in some waters

In general, these concerns can be addressed by standard water treatment methods and do not pose a significant threat to water supplies in the region.

Drawdown of aquifers poses a threat to small water suppliers and to household water use in rural areas. In particular region-wide pumping from the Trinity and Nacatoch aquifers is estimated to be greater than the recharge.

Groundwater quality in Region C aquifers is generally acceptable for most municipal and industrial purposes; however, natural concentrations of some contaminants in excess of drinking water standards occur in some areas.

In general, there are few significant water-related threats to agricultural resources in Region C due to the limited use of water for agricultural purposes.

Population and Water Demand Projections

The Texas Water Development Board's Senate Bill 1 planning guidelines require the use of TWDB's population and water demand projections from the *1997 Texas Water Plan* unless revisions are approved by TWDB based on changed conditions or new information. The adopted population and water demand projections are shown in Table 2-10. Most of the change from previous TWDB projections is in municipal demands, with smaller changes in steam electric power demands.

TABLE 2-10
POPULATION AND WATER DEMAND PROJECTIONS
2001 REGION C REGIONAL WATER SUPPLY PLAN

Year	Population	Water Demand [Acre-ft/Yr]
Historical 1996	4,609,060	1,126,518
2000	5,012,860	1,376,373
2010	5,882,173	1,695,661
2020	6,931,543	1,944,893
2030	7,850,797	2,149,826
2040	8,778,041	2,368,188
2050	9,481,157	2,536,902

Analysis of Water Supply Currently Available

The total water use in Region C in 1996 was over 1,100,000 acre-feet, of which about 74 percent came from in-region reservoirs. The projected total reliable water supply available to Region C in 2050 from current sources will be about 2,023,000 acre-feet per year, including:

- 1,138,000 acre-feet per year (56%) from in-region reservoirs
- 181,000 acre-feet per year (9%) from groundwater
- 70,000 acre-feet per year (3%) from local supplies
- 82,000 acre-feet per year (4%) from recycled

- 552,000 acre-feet per year (28%) from imports from other regions

The projected supply available to Region C from existing sources in 2050 is significantly less than the projected 2050 water use (Demand = 2,536,902 acre-feet per year vs. Supply = 2,023,000 acre-feet per year).

The available supply could be further limited by the capacities of the current raw water transmission facilities and wells. Most water suppliers will have to make significant improvements to their systems to realize the projected available supply. Also, the current groundwater use exceeds projected long-term supply in many parts of Region C.

Current Water Supply and Projected Water Demand

If no additional water supplies are developed, Region C will face substantial shortages in water supply over the next 50 years. The Region C Water Supply Plan findings can be summarized as follows:

- The currently connected supplies would meet only 52.5 percent of the projected 2050 demand.

- Without any additional supplies, the region's projected 2050 population would be limited to 6,078,289, instead of 9,481,157 (a 35.9% reduction)

- Without any additional supplies, the region's projected 2050 employment would be limited to 2,605,111, instead of 4,425,184 (a 41.1% reduction)

- Without any additional supplies, the region's projected 2050 income would be limited to $109,505,000,000, instead of $171,199,000,000 (a 36.3% reduction)

Evaluation and Selection of Water Management Strategies

The Region C Water Planning Group considered specific types of water management strategies for developing additional water supplies, including:

- Water conservation and drought response planning
- Recycling of treated wastewater
- Expanded use or acquisition of existing supplies
- Reallocation of reservoir storage to new uses
- Voluntary redistribution of water resources
- Voluntary subordination of water rights
- Enhancement of yields of existing sources
- Control of naturally occurring chlorides
- Interbasin transfers
- New supply development
- Water management strategies in the current state water plan
- Brush control, precipitation enhancements, and desalination
- Water right cancellation

- Aquifer storage and recovery
- Other

Recommended Water Management Strategies for Major Water Suppliers

A large part of the water supplied in Region C is provided by the five major water providers; DWU, TRWD, NTMWD, Fort Worth, and TRA. These entities will continue to provide the majority of the water supply through 2050 and will also develop most of the new future supplies.

The 2001 *Region C Regional Water Supply Plan* lists major plans for each of the major suppliers, highlights include:

- Marvin Nichols I Lake
- Connection of Lake Fork and Lake Palestine to the DWU System
- Develop recycled water project(s)
- Develop additional capacity from Richland-Chambers Reservoir
- Develop a water supply from Oklahoma
- Develop Lower Bois d'Arc Creek Reservoir

Recommended Water Management Strategies by County

The Region C Regional Water Supply Plan also provides a summary list of strategies for each county in the region.

Recommended Water Management Strategies Costs

The total capital costs of the strategies identified in the Plan are:

- Major Water Suppliers $4,483,304,000
- Other $1,674,637,000
- Total for Region C $6,157,941,000

Regional, Legislative, Administrative, and Other Recommendations

The Region C Water Planning Group made the following recommendations for regulatory, administrative, legislative, and other changes:

<u>Senate Bill 1 Planning Process</u>

- Allow alternative strategies for near- and long-term planning needs.
- Encourage TWDB to exercise discretion in consideration and approval of funding for alternatives not presented as part of the regional water plan.
- Encourage TCEQ to exercise discretion in the consideration and approval of water rights permit applications not part of the regional water plan.
- Allow regional water planning groups to assume that contracts for water supply will be renewed when they expire.
- Provide clarification of the impact of designating a unique stream segment.

TCEQ Policy and Water Rights

- Make some water rights exempt from cancellation for ten years of non-use.
- Reduce the regulatory and legislative obstacles to indirect reuse of treated wastewater.
- Remove barriers to interbasin transfers of water.

State and Federal Programs

- Increase funding for TWDB loans and the state participation program to assist with development of water supply projects.
- Accelerate studies of groundwater availability for the Trinity aquifer.
- Increase state participation in water conservation efforts.
- Provide a program for education of board members of Water Supply Corporations, Special Utility Districts, and Municipal Utility Districts.
- Increase state participation in watershed protection planning.
- Encourage federal funding for development, maintenance, and upgrading of Natural Resources Conservation Service (NRCS) structures.
- Provide state assistance with maintenance and construction of stock ponds.
- Encourage the Texas Agricultural Statistics Service to include water supply questions on its survey of farmers and ranchers.

Reservoir Construction

- Marvin Nichols I
- Lower Bois d'Arc Creek
- Muenster
- Tehuacana

Plan Approval Process and Public Participation

The Region C Water Planning Group documented their outreach efforts to water suppliers, regional planning groups, and the public. These efforts included questionnaires, joint planning meetings, newsletters, presentations, and public meetings and hearings.

Recommendations and Insights Related to Recycled Water from Region C Plan

Reuse of treated wastewater is becoming an increasingly important source of water in Region C and across Texas. Recycled water will serve a major role in meeting future water supply requirements. The 1997 Texas Water Plan projected that by 2050 recycled water will provide as much water as all other new water sources.

Direct recycled water and indirect recycled water have significantly different permitting requirements and potential applications. Direct recycled water requires a notification to the TCEQ and is most commonly used to supply water for landscape irrigation and industrial uses.

Indirect recycling occurs when treated wastewater is discharged to a stream or reservoir and is diverted downstream (or out of the reservoir). Discharge (TPDES) and water rights permits may be required for indirect recycling.

Recycled water has been a source of water supply in Region C for many years. A significant expansion of the water supply from recycled water is currently in the development stages, and includes:

- Landscape irrigation
- Agricultural irrigation
- Industrial and power generation reuse
- Recreational/environmental uses (lakes, ponds, wetlands, and stream flow augmentation)
- Supplementing potable water supplies

There are a number of benefits identified with recycled water use as a water management strategy for Region C, including:

- Represents an effective water conservation measure.
- Provides a reliable source that remains available in a drought.
- Quantities increase as population increases.
- Water demands that can be met by recycled water are often near recycled sources.
- Viable way to defer and avoid construction of new surface water impoundments.

The Region C Regional Water Supply Plan said that DWU could make use of return flows to its source water lakes. In 2000, DWU's return flows were estimated to be about 50,000 ac-ft/yr. Due to increasing pressure to reuse treated wastewater for other uses, the Water Supply Plan assumed that return flows to Dallas's lakes will decrease by 10,000 ac-ft/yr during each decade.

Other water supply alternatives include DWU's contracting with dischargers into the watersheds of its lakes to assure the continued availability of return flows. DWU has a great deal of return flow from its own treatment plants and could develop additional reuse projects.

The City of Dallas submitted to the Texas Commission on Environmental Quality (TCEQ) in April 2000, Applications 08-2462G and 08-245E, to amend their water rights to authorize conveyance, diversion, storage and reuse of a portion of the historic and future return flow of treated wastewater effluent from its two existing wastewater treatment plants (WWTPs).

Certificate of Adjudication No. 08-2462, as amended, authorizes the City of Dallas to maintain an existing dam and reservoir (Lake Ray Hubbard) on the East Fork Trinity River to impound 490,000 acre-feet of water. Dallas is also authorized to store up to 179,000 acre-feet of water conveyed by pipeline from Lake Tawakoni. Dallas is authorized to divert and use from the reservoir up to 89,700 acre-feet of water per year at a maximum rate of 619.00 cfs (277,807 gpm).

Similarly, Certificate of Adjudication No. 08-2456, as amended, authorizes the City of Dallas to store 549,976 acre-feet of water in an existing reservoir (Lake Lewisville) operated by the U. S. Army Corp of Engineers (USACOE), on the Elm Fork Trinity River. Dallas is authorized to divert and use up to 549,976 acre-feet of water per year at a maximum rate of 640.73 cfs (287,560 gpm).

The City of Dallas submitted Application 08-2462F and 08-2456E to add authorization to convey, store, divert, and reuse a portion of the treated effluent returned from the Central and Southside WWTPs.

In Application 08-2462F, Dallas seeks authorization to convey, store, divert, and reuse up to an additional 150,000 acre-feet per year from Lake Ray Hubbard based on the return flows delivered from the two Dallas WWTPs by pipeline.

Application 08-2456E seeks authorization to convey, store, divert, and reuse a portion of the treated effluent from four WWTPs, including Dallas's two WWTPs and the WWTPs of the City of Lewisville and the Town of Flower Mound. Dallas also seeks authorization to use the bed and banks of Baker's Branch, Denton Creek, Prairie Creek, the Elm Fork Trinity River, the Trinity River and Lake Lewisville to convey return flows to the diversion points described in the application.

The application states that the wastewater permit discharges from the four WWTPs associated with these applications are as shown in Table 2-12.

TABLE 2-11
WWTP EFFLUENT FLOW
APPLICATIONS 08-2456E AND 08-2462F

Plant	Maximum Annual Wastewater Permit Discharge [acre-feet]	Current 5-Year Average Annual Wastewater Effluent [acre-feet]
Dallas Central WWTP*	201,765	160,000
Dallas Southside WWTP*	100,882	83,000
City of Lewisville WWTP	13,451	9,400
Town of Flower Mound WWTP	5,605	3,800
Total	366,301	256,030

* Both Central and Southside WWTPs submitted permit amendment applications for flows greater than the permit limits in effect when Application 08-2456E and 08-2462F were submitted. The numbers in this table reflect March 2001 values.

The amendment applications were submitted to TCEQ (formerly TNRCC) on May 1, 2000, and additional information was submitted on March 23, 2001. The applications were determined to be administratively complete on December 5, 2001, and accepted by the Chief Clerk's Office for filing on July 25, 2002.

The major water providers on the Trinity River in Texas, including Dallas Water Utilities, Trinity River Authority of Texas, North Texas Municipal Water District, City of Fort Worth, and City of Houston have all submitted water rights applications and amendments to TCEQ (formerly TNRCC) within the past eight years. To date, none of these permits has been issued. The conditions to be included in the permits involve many complicated issues including balancing water supply needs, current water rights holders, and environmental needs. The time and attention being devoted to consideration of the permits shows the ever-increasing value placed on recycled water. Processing of these first permits has taken almost a decade. As the issues are resolved and tested, new precedents will be established and future permits should be drafted more efficiently.

CHAPTER 3

WATER SUPPLY, WATER DEMAND, AND TREATED WASTEWATER AVAILABILITY

3.1 Introduction

This chapter addresses the balances between DWU's current and projected water supplies, current and projected demands, and the availability of treated wastewater. Recycled water projects have been suggested as a strategy to help meet future water demand. Previous studies by DWU and others concluded that if no additional water supplies are developed, Region C and the DWU service area would face substantial shortages in water supply over the next 50 years, which could limit population growth, employment, and income. An understanding of the amount of treated wastewater that will be available is essential in planning for a recycled water system. Following the discussion of supply and demand is a discussion of sources of recycled water in the City of Dallas, population analyses for service areas, and anticipated wastewater flows.

3.2 Existing Water Supply and Demand

To determine if water demand is such that additional supplies are needed to augment existing projected water supplies, the existing water supply and demand were reviewed. In summary, existing water supply is projected to provide 666 MGD and water demand is projected to be 847 MGD in 2060 for DWU and its customers. The projected raw water transmission capacity is projected to be 938 MGD in 2060. The projections are presented below.

3.2.1 Water Supply

The City of Dallas uses or has rights to water from the following reservoirs:

Eastern System:

- Lake Ray Hubbard on the East Fork of the Trinity River near Rockwall, Texas
- Lake Tawakoni on the Sabine River south of Greenville, Texas

DWU holds the water rights in Lake Ray Hubbard. The Sabine River Authority of Texas (SRA) holds the water rights for Lake Tawakoni.

Western System:

- Ray Roberts Lake on the Elm Fork of the Trinity River north of Lewisville, Texas
- Lewisville Lake on the Elm Fork of the Trinity River near Lewisville, Texas
- Grapevine Lake on Denton Creek near Grapevine, Texas

All three western reservoirs are multipurpose U.S. Army Corps of Engineers (USACE) impoundments in which DWU holds water rights for water supply and storage. The annual diversion authorizations correspond to the original water supply storage capacity rather than their firm yields. This authority results in water rights that greatly exceed the firm (or dependable) yields that could be withdrawn during the drought of record. In addition to the reservoirs, DWU holds water rights for uncontrolled portions of the Elm Fork watershed.

Unconnected Reservoirs:

- Lake Palestine of the Neches River south of Tyler, Texas
- Lake Fork on Lake Fork Creek west of Quitman, Texas

Lake Fork Reservoir and Lake Palestine are not currently connected to the DWU system. The Upper Neches River Municipal Water Authority (UNRMWA) holds the Lake Palestine water rights. The Sabine River Authority of Texas (SRA) holds the water rights for Lake Fork.

In the March 2005 Draft Update – Long Range Water Supply Plan (LRWSP) elevation-area-capacity data were gathered and adjusted for the impact of sedimentation through year 2060. Table 3-1 is a summary of available water supply sources:

TABLE 3-1
WATER SUPPLY PROJECTIONS
2005 DRAFT LRWSP UPDATE

Source	Dependable Supply Available to DWU [MGD]					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
Ray Roberts Lake/Lewisville Lake (1)	152.3	150.5	148.7	146.8	145.0	143.3
Grapevine Lake (2)	6.5	6.1	5.7	5.3	4.9	4.5
Lake Ray Hubbard	66.3	66.3	66.3	66.3	66.3	66.3
Lake Tawakoni	163.9	162.7	161.5	160.3	159.0	157.8
Lake Fork (3)	107.0	107.0	107.0	107.0	107.0	107.0
Lake Palestine (3)	102.0	101.1	100.2	99.3	98.4	97.6
Reservoir Subtotal	**598.0**	**593.7**	**589.4**	**585.0**	**580.6**	**576.5**
Other Sources (4)						
CF75 (5)	10.0	10.0	10.0	10.0	10.0	10.0
Permit 5414 (6)	8.9	8.9	8.9	8.9	8.9	8.9
Return Flows (7)	30.7	39.9	47.4	54.1	62.3	71.0
Non-Reservoir Subtotal	**49.6**	**58.8**	**66.3**	**73.0**	**81.2**	**89.9**
Total Supply	**647.6**	**652.5**	**655.7**	**658.0**	**661.8**	**666.4**

Source: March 2005 Draft Update Long Range Water Supply Plan

Notes:
(1) DWU's share of Ray Roberts Lake's firm yield is 74.0 percent, and 95.18 percent of Lewisville Lake. The balance is controlled by the City of Denton.
(2) DWU's share of Grapevine Lake's firm yield is limited to 8.9 MGD per pending reservoir allocation plan.
(3) Lake Fork and Lake Palestine are not connected to DWU system.
(4) Elm Fork of the Trinity River exclusive of Ray Roberts Lake, Lewisville Lake, and Grapevine Lake
(5) Existing DWU CF75 permit allows for the use of 10.0 MGD of flow being added to the Trinity River below Lewisville Lake and Grapevine Lake.
(6) The interim Permit 5414 allows for the use of an additional 8.9 MGD below Lewisville and Grapevine dams.
(7) The supply shown is 40% of projected return flows to account for future unknowns in diversions and developments.

3.2.2 Water Demand

The 2005 LRWSP Update team obtained and analyzed historical water demand data from the Pumping, Planning, and Wholesale Services Divisions of DWU. From these data, the team estimated the following:

- Per capita water demand
- Affect of conservation
- Average-day water demand
- Peaking factors
- Impact of drought conditions
- Peak-day demands

Table 3-2 is a summary of the water forecast for the Total Water Demand, including Dallas plus current and potential treated and raw water customers. All of these projections are for average-day demand for long-term drought conditions.

TABLE 3-2
WATER DEMAND PROJECTIONS
2005 DRAFT LRWSP UPDATE

Year	Water Demand (MGD)
2010	529
2020	606
2060	847

3.2.3 Existing Raw Water Conveyance Capacity

DWU's raw water is supplied by reservoirs in the Trinity and Sabine River basins. Raw water from the western reservoirs is conveyed to the Bachman and Elm Fork water treatment plants by gravity through rivers and creeks, and then delivered by pump stations at the plants. Raw water from the eastern reservoirs is pumped to the East Side Water Treatment Plant from pump stations located at the lakes. Table 3-3, taken from the 2005 Draft LRWSP Update summarizes the existing raw water conveyance capacities.

DWU's firm capacity for raw water conveyance is sufficient to provide the needed demand based on the above projections. Therefore, establishing recycled water as a raw water supply either for direct recycling or water supply augmentation is crucial for extending the current available supply, utilizing existing capacity, and meeting future needs.

TABLE 3-3
RAW WATER CONVEYANCE CAPACITIES

Water Treatment Plant	Total Capacity (MGD)	Largest Pump (MGD)	Firm Capacity (MGD)
Western System			
Elm Fork WTP	376	38	338 (1)
Bachman WTP	200	40	160
Western System Subtotal	576	n/a	498 (1)
Eastern System			
East Side WTP			
Forney PS	352	58	200 (5)
Iron Bridge PS & Tawakoni Balancing Reservoir (4)	260 Pump 240 Grav	35	225
Eastern System Subtotal	460(6)	n/a	440 (2)
DWU System Total (3)	**1036**	**n/a**	**938**

Source: March 2005 Draft Update Long Range Water Supply Plan

Notes:
(1) Total firm capacity equals the sum of individual capacities minus the largest pump in the group.
(2) For eastern system, the firm capacity is controlled by the water rights permit for Lake Ray Hubbard (limited to 200 MGD) plus the gravity capacity from the balancing reservoir (240 MGD).
(3) DWU overall system capacity equals sum of western and eastern systems.
(4) Iron Bridge PS capacities are based on 24-hour operation at full capacity (not time-of-day electrical metering).
(5) The Water Rights Permit for Lake Ray Hubbard limits diversion rates to 200 MGD.
(6) For eastern system, the total capacity is controlled by the water rights permit for Lake Ray Hubbard (limited to 200 MGD) plus the pumping capacity from the balancing reservoir.

3.2.4 Water Supply and Demand Summary

Table 3-3 lists a firm capacity of 938 MGD in the DWU system for raw water conveyance. The available supply from current water sources is projected to be approximately 666 MGD in 2060. The demand is projected to be approximately 847 MGD in 2060, as listed in Table 3-2. Therefore, demand in 2060 is greater than current water supply, and additional supply will be required to meet projected needs. Sufficient raw water conveyance is available to meet the projected demands and could support additional supply provided by other water supply projects such as raw water augmentation using recycled water.

3.3 Treated Effluent Availability for Recycled Uses

In order to determine the amount of recycled water potentially available, an evaluation was first made of the population and population projections within wastewater service areas. An estimate of per capita wastewater flow was then applied to the population projections, resulting in a projection of wastewater flows which would be available for recycled water usage.

The source for evaluating projected wastewater flows available for recycled water use was intended to be the updated population and wastewater flow projections developed by Dallas Water Utilities' wastewater master planning consultant. The population projections developed by this consultant were to be compared with the population projections of the Texas Water Development Board (TWDB), Region C and the North Central Texas Council of Governments (NCTCOG) for compatibility and consistency. At the time of the development of this implementation plan, DWU was negotiating with Montgomery Watson Engineers for the update to the City of Dallas's Wastewater Master Plan. The data contained within this wastewater master plan were to be utilized for wastewater flow projections for the Recycled Water Implementation Plan. Since these data were not available at the time of the preparation of this implementation plan, populations (and flows) were estimated from other sources. The following section describes population sources reviewed and population forecasts for the Dallas area.

3.3.1 Population Projections for Dallas Area

Population estimates can vary widely depending on the methodology used. Population forecasts are comprised of many variables and the relative importance assigned to each variable will influence the outcome of the estimate. These variables may include fertility, net immigration, life expectancy, employment opportunities, and availability of land and housing. Even given the best available data, forecasts can depart widely from actual future populations due to unforeseen events.

For many agencies, including TWDB and NCTCOG, the U.S. Bureau of the Census population data are considered to be the most reliable source for current population data. Therefore, these agencies used the U.S. Bureau of the Census population data for the census year to establish and correct the direction of their trend lines.

There are several sources of population projections for the Dallas area. The following sources were considered in the population projection evaluation and an overview of these sources also presented:

- Water Quality Management Plan of North Central Texas developed by the North Central Texas Council of Governments
- Senate Bill 1, Region C Water Plan as adopted by the Texas Water Development Board (2001)
- 2002 Dallas Water Utilities Population Projections
- Draft of the 2004 Water Master Plan (Black & Veatch)
- 1994 Wastewater Master Plan Update (CH2M Hill)
- TWDB Population Projections, November 2003

NCTCOG Water Quality Management Plan of North Central Texas Population Projections

The North Central Texas Council of Governments is the designated water quality management planning agency for North Central Texas. As part of its responsibilities, NCTCOG prepares annual updates to the Water Quality Management Plan (Annual Plan) that presents information on water quality activities and initiatives for enhancing water quality within the region. The Plan provides updates on water quality monitoring, assessment and pollution abatement activities in the 12 watersheds of the Upper Trinity River Basin. Each watershed assessment includes information on water pollution control, abatement activities, population projections and wastewater flow projections.

The Annual Plan is reviewed by municipalities and interested entities within the NCTCOG planning area. Public participation is provided through a formal public hearing. Following the public hearing, final modifications are incorporated into the Annual Plan; and it is adopted by the NCTCOG Executive Board. The Annual Plan is then submitted to the TCEQ and the USEPA Region 6 for review. Final endorsement occurs when the TCEQ certifies the Annual Plan.

NCTCOG's Population Projection Methodology

NCTCOG's population estimates were based on housing inventories and reviewed for consistency with other indicators of regional population such as labor force estimates and vital statistics. Each city in the NCTCOG region provided information on building completions, demolitions, annexations, and other changes in housing stock that occurred during the previous year. Other factors include building permits, estimates of people living in nursing homes, dormitories, etc., and person per household and occupancy rates, adjusted to account for national trends as well as regional and local rates. County-level estimates were adjusted for cities that are in more than one county. This procedure was used to produce projections for residential population as well as employment population. NCTCOG's recommended figures were reviewed by local city and county professionals prior to final approval.

Table 3-4 presents the North Central Texas Council of Governments' residential and employment population projections for Dallas and its wastewater customer cities.

NCTCOG's Wastewater Flow Projection Methodology

Projected wastewater flows were calculated utilizing residential and employment population data. The residential population was considered to contribute a per capita wastewater flow and an infiltration/inflow contribution. The employment population was considered to contribute a per capita flow. The per capita rates utilized by NCTCOG were:

Residential	100.06 gpcd
Employment	43.15 gpcd
I&I	33 gpcd

In preparing the 2003 Water Quality Management Plan, NCTCOG used the following 2030 population projection for the Dallas wastewater system:

Residential	1,433,203 persons
Employment	1,412,309 persons

Table 3-4
North Central Texas Council of Governments
2003 Population Projections

	2005	2010		2015	2020		2025	2030	
	Residential	**Residential**	**Employment**	**Residential**	**Residential**	**Employment**	**Residential**	**Residential**	**Employment**
Addison	15,611	18,360	54,505	19,303	19,303	64,049	19,303	19,303	66,213
Balch Springs	20,694	22,218	6,980	25,842	28,427	8,560	30,209	34,247	9,044
Cockrell Hill	4,436	4,451	749	4,451	4,451	779	4,451	4,451	779
Dallas	1,239,190	1,268,500	1,158,522	1,294,003	1,319,788	1,282,463	1,375,983	1,404,847	1,390,219
Duncanville	36,425	36,503	15,509	36,595	36,912	17,579	37,714	37,714	18,983
Highland Park	9,025	9,027	2,578	9,027	9,027	2,586	9,027	9,027	2,586
Hutchins	2,687	2,840	3,630	2,974	3,152	4,426	3,722	4,021	8,785
Mesquite	132,988	136,175	64,733	143,014	149,262	75,232	151,838	157,259	77,015
Richardson	101,557	102,342	120,456	106,518	108,412	141,385	112,693	113,815	163,014
University Park	20,764	20,764	9,690	20,764	20,764	9,707	20,764	20,764	9,716
Wilmer	3,097	3,175	1,339	3,408	3,868	1,887	4,405	4,847	5,055
Total	1,586,474	1,624,355	1,438,691	1,665,899	1,703,366	1,608,653	1,770,109	1,810,295	1,751,409

This resulted in the following wastewater flow estimate for the year 2030:

Residential	143.41 MGD
Employment	60.94 MGD
I&I	47.30 MGD
Total	251.65 MGD

The flow projections for incremental years between 2000 and 2030 were interpolated using the reported average monthly flow of 216.51 MGD for year 2000 and the calculated flow for year 2030 of 251.65 MGD. These data are shown in Appendix F: "Wastewater Treatment Planning Needs and Individual System Assessments" of the 2003 Annual Water Quality Management Plan of North Central Texas.

TWDB Senate Bill 1, Region C Population Projections

The Texas Water Development Board (TWDB) provides technical services for the planning, conservation, and development of water in Texas. As a part of this technical service, TWDB guides the development of regional water plans, conducts studies and creates models of Texas's surface and groundwater resources, projects future water availability and incorporates regional water plans into a statewide water plan for the development, management, and conservation of the state's water resources.

In June 1997, Senate Bill 1, comprehensive water legislation enacted by the 75th Texas Legislature, put in place a water planning process designed to ensure that the water needs of Texas are met. Senate Bill 1 allows regional planning groups to prepare regional water plans for their areas. These plans map out how to conserve water supplies, meet future water supply needs and respond to future droughts in the planning areas. Senate Bill 1 designated TWDB as the lead state agency for coordinating the regional water planning process and developing a comprehensive state water plan.

The Senate Bill 1, Region C Water Plan was developed in 2001 and is scheduled to be updated in 2006. The Region C Water Plan, which covers all or part of 16 counties in North Central Texas, was developed under the direction of the TWDB and includes population projections. The TWDB has recently completed its population projections for Region C. These projections, which were last updated November 19, 2003, have been approved by the TWDB for use in the 2006 Regional Water Plan.

The methodology utilized by TWDB for projecting populations used separate groups of age, sex, race and ethnicity, and components of change, i.e., fertility rates, survival rates, and migration rates, to calculate future populations. Projections for each group were then summed to the total population.

There were four main steps in applying the method:

- Project the population living at the beginning of the year who will survive to the target year.

- Project net migration by multiplying net migration rates by the adjusted population in the launch year.

- Project the number of births and the net impact of mortality and migration on the youngest age group.

- Combine the results from the mortality, migration, and fertility.

To develop the population projections, the Region C planning group went through the following steps:

- Historical data and previous TWDB projections were reviewed by counties, cities, water suppliers, industries, and other interested entities.

- TWDB data and a questionnaire were sent to all Region C counties, cities with a population over 1,000, regional water suppliers, retail water suppliers, and large industries.

- Population data from the State Data Center and the North Central Texas Council of Governments were gathered.

- Previous TWDB population projections for each county were reviewed and changes to projections where current populations deviate significantly from the previous projections were recommended.

- Once the county population projections were completed, the city population projections were adjusted based on historical trends and knowledge of expected future development. The county populations served as controls in this process, and all population not assigned to a particular city was included as other.

Table 3-5 presents the Texas Water Development Board Region C population projections for Dallas and its wastewater customer cities. These projections, developed in 2003, have been approved by the Texas Water Development Board for use in the 2006 Region C Water Plan.

Dallas Water Utilities 2002 Future Population Serviced by DWU

In 2002, Dallas Water Utilities prepared its projections of population for the area serviced by the Dallas wastewater system and provided the results to NCTCOG during the development of the 2003 Water Quality Management Plan. Dallas's population projections differed significantly from NCTCOG's projections. NCTCOG stated, "The methodology used by the City of Dallas to forecast its future population is significantly different from COG methodology."

TABLE 3-5
TEXAS WATER DEVELOPMENT BOARD
2006 REGIONAL WATER PLAN DATA

Wastewater Customers	1990 Census	2000 Census	2010	2020	2030	2040	2050	2060
Addison	8,783	14,166	17,919	20,534	22,358	23,629	24,515	25,133
Balch Springs	17,406	19,375	21,083	22,564	23,849	24,963	25,930	26,768
Cockrell Hill	3,746	4,443	4,782	4,947	5,028	5,067	5,086	5,095
Dallas	1,006,877	1,188,580	1,312,324	1,451,878	1,525,450	1,598,223	1,764,681	2,058,767
Duncanville	35,748	36,081	37,100	38,069	38,988	39,862	40,692	41,480
Highland Park	8,739	8,842	8,937	9,025	9,106	9,181	9,249	9,313
Hutchins	2,719	2,805	5,000	10,000	16,000	24,000	32,000	34,000
Mesquite	101,484	124,523	160,002	195,003	225,004	242,006	249,008	250,610
Richardson	74,840	91,776	102,880	116,000	116,000	116,000	116,000	116,000
University Park	22,259	23,324	24,092	24,647	25,046	25,335	25,543	25,693
Wilmer	2,479	3,393	5,500	7,500	8,800	10,500	14,000	22,000
Total	1,285,080	1,517,308	1,699,619	1,900,167	2,015,629	2,118,766	2,306,704	2,614,859

In developing population projections, Dallas utilized the Senate Bill 1, 2001 Region C Water Plan population projections along with the 2000 Census data.

For the customer cities, the growth rate projected by TWDB for each decade was computed and applied to the 2000 Census population data. For Addison, Duncanville, Mesquite, and Richardson, the 2000 Census population was adjusted to reflect only that portion of each city that is served by the Dallas wastewater system. The adjustments were 67.43 percent, 10.53 percent, 0.61 percent and 31.46 percent for Addison, Duncanville, Mesquite, and Richardson, respectively.

For Dallas, the growth rate experienced between 1990 and 2000 was computed (18.1%) and applied to each ten-year period from 2010 thru 2030.

Dallas Water Utilities Draft 2004 Water Master Plan

Black and Veatch was authorized by the City of Dallas to prepare a water master plan for the City. The project, entitled *Water Capital Infrastructure Assessment and Hydraulic Modeling*, is presently underway. A draft copy of the Water Master Plan was provided to the APAI team in December 2003. As a part of the Water Master Plan, historical and projected population data for the City of Dallas and for the customer cities that are served through the DWU treated water distribution system were being evaluated. For raw water supply facilities planning, the total population served was considered of primary importance. For planning of the water distribution system, the distribution of population throughout the service area was considered of primary importance, since the facilities must be located and sized to meet demand in localized areas.

The sources of population projections that the DWU Water Master Plan utilized for Dallas and its water customer cities included the following:

- North Central Texas Council of Governments
- Texas Water Development Board
- 2000 Long Range Water Supply Plan (LRWSP)

The draft of the Water Master Plan states that the NCTCOG population projections were to be used for the following reasons:

- The NCTCOG population projections have significant input from local city planning officials and are used for planning purposes by many cities throughout the DFW Metroplex. NCTCOG projections include analysis of vacant land available for development and other local considerations that impact future growth. In addition, the NCTCOG projections provide population breakdowns for smaller geographic areas (traffic zones), which are very important for water distribution planning.

- The TWDB population projections are primarily based on extrapolation of historical development rates and generally have less input from local planning officials. The TWDB projections are for each city as a whole and do not provide population breakdowns for smaller geographical areas, which are essential for water distribution planning.

- The LRWSP population projections were developed in the late 1990s and were generally based on the then-latest NCTCOG and TWDB projections. Both NCTCOG and TWDB have since updated their projections to better reflect the latest development trends. The LRWSP projections were made before the year 2000 and thus could not reflect the results of the 2000 census. As a result, some of the baseline populations that were used for the LRWSP have been shown to be significantly low. Like the TWDB projections, the LRWSP projections are also on a citywide basis and do not provide population breakdowns for small geographical areas.

Since the Draft Water Master Plan utilized the NCTCOG population projections, the data contained in Table 3-4 reflect the same population projections for Dallas and its wastewater customer cities.

Dallas Water Utilities 1994 Wastewater Master Plan

In 1991, the City of Dallas contracted with CH2M HILL to update the Wastewater System Master Plan, with specific emphasis on the interceptor-sewer system. As a part of this Wastewater System Master Plan Update, population projections and wastewater flow projections were presented. In the effort to develop population projections, information from a variety of sources was examined for the Wastewater System Master Plan Update. Population projections from NCTCOG were utilized as the primary source. These projections were compared to the population projections used by Black and Veatch in 1985 and HDR Engineering in 1988. The consultant considered the NCTCOG data to be the best available information.

The projections developed in the 1994 Wastewater Master Plan were based on the following:

- Utilized current NCTCOG population projections to the year 2010.

- When the slope of the population-projection plot for a sewer-shed at the year 2010 was positive, extended this slope to project the population to 2025.

- When the slope of the population-projection-versus-time plot for a sewer-shed at the year 2010 was negative, assumed that the population remained the same from 2010 to 2025.

Population Projections Findings Relevant to Recycled Water Implementation

The draft of the 2004 Water Master Plan and the 1994 Wastewater Master Plan Update evaluated the population projections prepared by the North Central Texas Council of Governments and the Texas Water Development Board and concluded that the North Central Texas Council of Governments population projections provided the best available information (see Table 3-4). NCTCOG was considered the best available source primarily because the NCTCOG projections had input from local planning officials while TWDB projections were primarily based on extrapolation of historical development rates and generally had less input from local planning officials. NCTCOG projections are utilized for planning purposes by many of the cities throughout the Dallas-Fort Worth Metroplex.

The Texas Water Development Board has recently completed its population projections for Region C. These projections, updated November 19, 2003, have been approved by the Texas

Water Development Board for use in the 2006 TWDB Regional Water Plan (see Table 3-5). Since the Texas Water Development Board projections are the most current, the TWDB population projections will be utilized in this analysis.

3.3.2 Recycled Water Sources

The City of Dallas provides wastewater treatment for most of the City of Dallas and all or part of ten customer cities. Treatment of the wastewater received from these sources is provided by two wastewater treatment plants, Central Wastewater Treatment Plant and Southside Wastewater Treatment Plant.

The Central Wastewater Treatment Plant is located on the Trinity River, south of downtown. It currently has a permitted average daily flow of 150 MGD. Central WWTP receives wastewater flow from Dallas and from customer cities including all or part of Addison, Cockrell Hill, Richardson, Duncanville, Highland Park and University Park.

Southside Wastewater Treatment Plant is located on the Trinity River in southeast Dallas County. It currently has a permitted average daily flow of 110 MGD. The cities that Southside WWTP serve include all or part of Dallas, Addison, Cockrell Hill, Balch Springs, Duncanville, Highland Park, Hutchins, Mesquite, Richardson, University Park, and Wilmer.

Currently, the source for recycled water in the City of Dallas includes treated wastewater from the two wastewater treatment plants, Central WWTP and Southside WWTP, and from potential future satellite wastewater treatment plants (water factories) that may be located within the wastewater collection system. The projected wastewater flow from a WWTP is dependent on the total population of the area served by the plant. A water factory, however, is dependent on the population of that portion of the sewershed located upstream of the proposed water factory.

3.3.3 Population Projections for Areas Served by DWU WWTPs

The above sources provided total population projections for each city in the Dallas area. Since the wastewater treatment plants receive wastewater flows from only portions of some of the cities, each city's population projections had to be evaluated to determine that portion of the population that is served by Dallas's wastewater treatment plants. A per capita wastewater usage rate was then applied to the resulting population projections.

The population analysis is therefore divided into two categories, projections for the total area served by Central WWTP and Southside WWTP and projections for specific areas within the wastewater collection system. The population projections for specific areas will be included in later chapters as a part of the analysis for individual recycled water customers, projects and service areas.

3.3.4 Wastewater Flow Projections for Areas Served by DWU WWTPs

The first step in developing wastewater flow projections is to determine how much of the individual city's population is served by Dallas's wastewater treatment plants. Of the ten customer cities, four (Addison, Duncanville, Mesquite and Richardson) are only partially served by Dallas's wastewater system.

In 2002, Dallas Water Utilities utilized the 2000 census population data to develop its projections (see Table 3-6). For Addison, 67.43 percent of the 2000 Census population was served by DWU; for Duncanville, 10.53 percent; for Mesquite, 0.61 percent and for Richardson, 31.46 percent. Utilizing the percentages for these four wastewater customer cities and 100 percent for the six other customer cities, the TWDB population projections were adjusted to determine the population of the Dallas wastewater system. The results are shown in Table 3-7.

TABLE 3-6
DALLAS WATER UTILITIES
2002 HISTORIC AND FUTURE POPULATION SERVED BY DWU WASTEWATER SYSTEM

	1990 Census	2000 Census	2000	2010	2020	2030
Addison	8,783	14,166	9,552	11,410	12,713	14,030
Balch Springs	17,406	19,375	19,375	22,193	24,271	25,325
Cockrell Hill	3,746	4,443	4,443	4,499	4,633	4,691
Dallas	1,006,877	1,188,580	1,188,580	1,403,073	1,656,275	1,955,169
Duncanville	35,748	36,081	3,800	4,192	4,482	4,604
Highland Park	8,739	8,842	8,842	9,249	9,674	10,118
Hutchins	2,719	2,805	2,805	3,324	4,033	4,996
Mesquite	101,484	124,523	765	897	1,037	1,174
Richardson	74,840	91,776	28,869	31,671	34,213	35,777
University Park	22,259	23,324	23,324	23,907	24,505	25,117
Wilmer	2,479	3,393	3,393	3,615	3,853	4,016
Total	1,285,080	1,517,308	1,293,748	1,518,030	1,779,689	2,085,017

The total projected flows for Central WWTP and Southside WWTP have been estimated utilizing the procedure developed by NCTCOG, as discussed in Section 3.3.1. The per capita flow rates utilized in this analysis were: residential- 100.06 gpcd, employment- 43.15 gpcd and inflows and infiltration (I&I)- 33 gpcd. The results of this analysis are shown in Table 3-8. Wastewater flows for specific service areas in the City of Dallas will be discussed further in Chapter 9.

The total projected flows for the Central and Southside WWTPs are provided in Table 3-8. These flows were developed using NCTCOG methodologies which are discussed in Section 3.3.1. The development of these projections is fully documented in the Technical Memorandum- *Preliminary DWU Flow Projections*, May 6, 2005, by MWH. The average year projections are used as a conservative estimate of water availability.

TABLE 3-7
TWDB POPULATION PROJECTIONS
ADJUSTED FOR DWU WASTEWATER SERVICE AREA

	2010	2020	2030	2040	2050	2060
Addison	12,083	13,846	15,076	15,933	16,530	16,947
Balch Springs	21,083	22,564	23,849	24,963	25,930	26,768
Cockrell Hill	4,782	4,947	5,028	5,067	5,086	5,095
Dallas	1,312,324	1,451,878	1,525,450	1,598,223	1,764,681	2,058,767
Duncanville	3,907	4,009	4,105	4,197	4,285	4,368
Highland Park	8,937	9,025	9,106	9,181	9,249	9,313
Hutchins	5,000	10,000	16,000	24,000	32,000	34,000
Mesquite	976	1,190	1,373	1,476	1,519	1,529
Richardson	32,366	36,494	36,494	36,494	36,494	36,494
University Park	24,092	24,647	25,046	25,335	25,543	25,693
Wilmer	5,500	7,500	8,800	10,500	14,000	22,000
Total	1,431,049	1,586,099	1,670,327	1,755,369	1,935,317	2,240,973

TABLE 3-8
PROJECTED TOTAL WASTEWATER FLOWS
CENTRAL WWTP AND SOUTHSIDE WWTP

Year	NCTCOG Data Population (Millions)	Region C Data Population (Millions)	NCTCOG Data			Region C1		
			Avg Year[1] Flow (MGD)	Wet Year[2] Flow (MGD)	Design[3] Flow (MGD)	Avg Year[1] Flow (MGD)	Wet Year[2] Flow (MGD)	Design[3] Flow (MGD)
2000	1.25	1.23	205	228	243	204	226	226
2005	1.28	1.30	210	232	247	211	234	234
2010	1.31	1.36	213	236	251	219	241	256
2015	1.34	1.43	217	239	254	226	249	264
2020	1.37	1.50	221	243	258	235	258	273
2025	1.42	1.54	227	250	265	240	262	277
2030	1.45	1.58	230	253	268	244	268	281

1 "Avg Year" = combined impact of dry + wet conditions.
2 "Wet Year" = dry + wet + especially wet conditions.
3 "Design" = dry + wet + especially wet + 15 MGD allowance for future change in service area.

Source: Central Wastewater Collection System Assessment, May 6, 2005.

(This page intentionally left blank.).

CHAPTER 4

RECYCLED WATER STANDARDS

4.1 Effluent Reuse Standards and Regulations

Part of development of this recycled water implementation plan involved the review of the current status of effluent reuse standards and regulations. While there is much ongoing discussion and activity surrounding water reuse throughout the United States, at this time, there are no Federal regulations related to the practice of water reuse. The EPA did issue guidelines in 1992. These guidelines were updated in September 2004 (EPA/625/R-04/108). Many states have developed their own regulations. This chapter describes the types of regulations currently enacted by individual states and the ranges of values assigned to the various parameters selected for regulation in water reuse applications. This chapter also presents a summary of information provided in the updated EPA guidelines.

4.2 Focus of Regulations

Regulations tend to focus either on using recycled water as a resource or providing an alternative to a stream discharge. The regulations that have been established tend to be a function of the potential for human contact with the recycled water either through physical contact or ingestion of food – the more likely the contact, the more stringent the regulations. Guidelines and regulations are typically divided into the following reuse categories:

- Unrestricted urban reuse – irrigation of areas in which public access is not restricted, such as parks, playgrounds, school yards, and residences; toilet flushing, air conditioning, fire protection, construction, ornamental fountains, and aesthetic impoundments.

- Restricted urban reuse – irrigation of areas in which public access can be controlled, such as golf sources, cemeteries, and highway medians.

- Agricultural reuse on food crops – irrigation of food crops which are intended for human consumption, often further classified as to whether the food crop is to be processed or consumed raw.

- Agricultural reuse on nonfood crops – irrigation of fodder, fiber, and seed crops, pasture land, commercial nurseries, and sod farms.

- Unrestricted recreational reuse - an impoundment of reclaimed water in which no limitations are imposed on body-contact water recreation activities.

- Restricted recreational reuse – an impoundment of reclaimed water in which recreation is limited to fishing, boating, and other non-contact recreational activities.

- Environmental reuse – reclaimed water used to create manmade wetlands, enhance natural wetlands, and to sustain stream flows.

- Industrial reuse – reclaimed water used in industrial facilities primarily for cooling system make-up water, boiler-feed water, process water, and general washdown.

- Groundwater recharge – using infiltration basins, percolation ponds, or injection wells to recharge an aquifer.

- Indirect potable reuse – the intentional discharge of highly treated reclaimed water into surface water or groundwater that is used or will be used as a source of potable water.

Table 4-1 presents a summary of the number of states with various types of reuse applications. Table 4-2 lists all states and presents the distribution of reclaimed water guidelines or regulations by reuse application type. Some states have regulations (enforceable rules), others have guidelines (not enforceable but can be used to develop programs), some have both, and others have neither. The states with the most comprehensive regulations include Arizona, California, Florida, Hawaii, Massachusetts, Nevada, New Jersey, North Carolina, Oregon, South Dakota, Texas, Utah, and Washington.

TABLE 4-1
Number of States with Regulations or Guidelines for Each Type of Reuse Application

Type of Reuse[1]	Number of States
Unrestricted Urban	28
Irrigation	28
Toilet Flushing	10
Fire Protection	9
Construction	9
Landscape Irrigation	11
Street Cleaning	6
Restricted Urban	34
Agricultural (Food Crops)	21
Agricultural (Non-food Crops)	40
Unrestricted Recreational	7
Restricted Recreational	9
Environmental (Wetlands)	3
Industrial	9
Groundwater Recharge (Nonpotable Aquifer)	9
Indirect Potable Reuse	5

[1]It is important to note that just because a particular type of reuse is not specifically mentioned in a State's regulations does not mean that it is not allowed.

Table 4-2
Summary of State Reuse Regulations and Guidelines

State	Regulations	Guidelines	No Regulations or Guidelines (1)	Change from 1992 Guidelines for Water Reuse (2)	Unrestricted Urban Reuse	Restricted Urban Reuse	Agricultural Reuse Food Crops	Agricultural Reuse Non-Food Crops	Unrestricted Recreational Reuse	Restricted Recreational Reuse	Environmental Reuse	Industrial Reuse	Groundwater Recharge	Indirect Potable Reuse
Alabama		•		N		•		•						
Alaska	•			NR				•						
Arizona	•			U	•	•	•	•		•				
Arkansas		•		N	•	•	•	•						
California (3)	•			U	•	•	•	•	•	•		•	•	•
Colorado	•(4)			GR	•	•	•	•	•	•				
Connecticut			•	N										
Delaware	•			GR	•	•		•						
Florida	•			U	•	•	•	•			•	•	•	•
Georgia		•		U	•	•		•						
Hawaii		•		U	•	•	•	•		•		•	•	•
Idaho	•			N	•	•	•	•						
Illinois	•			U	•	•		•						
Indiana	•			U	•	•	•	•						
Iowa	•			NR		•		•						
Kansas		•		N	•	•	•	•						
Kentucky			•	N										
Louisiana			•	N										
Maine			•	N										
Maryland		•		N		•		•						
Massachusetts		•		NG	•	•		•					•	•
Michigan	•			N			•	•						
Minnesota			•	N										
Mississippi			•	N										
Missouri	•			N		•		•						
Montana		•		U	•	•	•	•						
Nebraska	•			GR		•		•						
Nevada	•			GR	•	•	•	•	•	•				
New Hampshire			•	N										
New Jersey		•		RG	•	•	•	•				•		
New Mexico		•		N	•	•	•	•						
New York		•		N				•						
North Carolina	•			U	•	•						•		
North Dakota		•		U	•	•		•						
Ohio		•		NG	•	•		•						
Oklahoma	•			GR		•	•	•						
Oregon	•			N	•	•	•	•	•	•		•		
Pennsylvania		•		NG				•						
Rhode Island			•	N										
South Carolina	•			GR	•	•		•						
South Dakota		•		N	•	•		•			•			
Tennessee	•			N	•	•		•						
Texas	•			U	•	•	•	•	•	•		•		
Utah	•			U	•	•	•	•	•	•		•		
Vermont	•			N				•						
Virginia			•	N										
Washington		•		U	•	•	•	•	•	•	•	•	•	•
West Virginia	•			N			•	•						
Wisconsin	•			N				•						
Wyoming	•			U	•	•	•	•						

(1) Specific regulations on reuse not adopted; however, reclamation may be approved on a case-by-case basis.
(2) N - no change; GR - guidelines to regulations; NG - no guidelines or regulations to guidelines; U - updated guidelines or regulations; NR - no guidelines or regulations to regulations; RG - regulations to guidelines
(3) Has regulations for landscape irrigation excluding residential irrigation; guidelines cover all other uses.

4.3 Summary of Texas Reclaimed Water Regulations

In the State of Texas, the use of reclaimed water for beneficial purposes is regulated by the Texas Commission on Environmental Quality (TCEQ). The specific regulations are codified in Title 30, Chapter 210 of the Texas Administrative Code (30 TAC Ch. 210). Chapter 210 defines two types of reclaimed water based on the likelihood that the water would come in contact with humans. Regulations concerning the quality of the water, design of reclaimed water storage facilities, restrictions on the use of reclaimed water, and the frequency of monitoring are different for the two types of reclaimed water. Table 4-3 summarizes current Type I and Type II requirements. The following is a summary of potential reclaimed water uses regulated by reclaimed water type.

Type I Reclaimed Water

Type I reclaimed water can be used in instances where incidental contact with humans is likely to occur. The following uses are identified as Type I Uses.

- Residential irrigation
- Unrestricted urban irrigation, including parks, school yards, and athletic fields
- Fire protection systems
- Direct irrigation of food crops that will be peeled, skinned, cooked, or thermally processed
- Irrigation of pastures for milking animals
- Maintenance of unrestricted recreational impoundments
- Toilet or urinal flush water
- Other similar activities where the potential for unintentional human exposure may occur

In order to be considered Type I Reclaimed Water, treated effluent must meet specific quality requirements; specific treatment processes are not identified or required. These parameters must be monitored twice per week and reported on a monthly basis.

Type II Reclaimed Water

Type II reclaimed water can be used in instances where incidental contact with humans is not likely to occur. The following uses are identified as Type II Uses.

- Irrigation of restricted areas, such as golf courses, sod farms, silviculture, or highway rights-of-way
- Indirect irrigation of food crops that will be peeled, skinned, cooked, or thermally processed
- Irrigation of animal feed crops other than pastures for milking animals
- Maintenance of restricted recreational impoundments
- Soil compaction or dust control in construction activities
- Cooling tower make-up water
- Nonpotable uses at wastewater treatment plants
- Other similar activities where the potential for unintentional human exposure is not likely

TABLE 4-3
CHAPTER 210: RECLAIMED WATER USES
TYPE I AND II REQUIREMENTS

Item	Type I	Type II
Definition	Reclaimed water use where contact with humans is likely	Reclaimed water use where contact with humans is unlikely
Uses	Irrigation or other uses in areas where public may be present	Irrigation or other uses in areas where the public is not present
Examples of Uses	• Residential irrigation. • Irrigation of public parks, golf courses, and athletic fields. • Fire protection. • Irrigation of food crops. • Irrigation of pastures for milking animals. • Maintenance of impoundments or natural waterbodies where recreational activities are anticipated. • Toilet or urinal flush water. • Other activities where potential for unintentional human exposure.	• Irrigation of sod farms, silviculture, limited access and ROWs where human access is restricted or unlikely. Irrigation of food crops. 1. Remote site 2. Controlled access 3. Site not used by public when irrigating (golf courses, cemeteries, and landscaped areas surrounding commercial or industrial complexes) 4. Restricted by ordinance • Irrigation of food crops without contact with edible part or with pasteurization. • Irrigation of animal feed crops. • Maintenance of impoundments/waterbodies where direct human contact is unlikely. • Soil compaction or dust control. • Cooling tower make-up water. • Irrigation or other nonpotable uses at a WWTP.
Quality Standards (30-day averages)	• BOD5/CBOD5 = 5 mg/l • Turbidity = 3 NTU • Fecal coliform<20 or <75 CFU/100ml single grab	• BOD5 = 20 mg/l or • CBOD5 = 15 mg/l • Fecal coliform<200 or <800 CFU/100ml single grab • For a pond system: 1. BOD5 = 30 mg/l 2. Fecal coliform<200 or <800 CFU/100ml single grab
Sampling and Analysis	Twice per week	Once per week

In order to be considered Type II Reclaimed Water, treated effluent must meet specific quality requirements; specific treatment processes are not identified or required. These parameters must be monitored once per week and reported on a monthly basis.

<u>Other Reclaimed Water Uses</u>

The Texas regulations also include an alternative approval process for uses or designs that are not specifically identified in the rules. Projects requiring an alternative approval are considered on a case-by-case basis and would include any indirect potable application, as well as any reuse of industrial reclaimed water.

<u>Revision of Reclaimed Water Regulations</u>

The rules for reclaimed water have been in effect since 1997. A subcommittee of the Texas AWWA Water Conservation and Reuse Division is currently reviewing them to identify rule revisions that may be needed based on implementation constraints and technological changes. There has been some discussion of lowering the current Type I turbidity limit of 3 NTU to 2 NTU based on limits set by other states. An investigation into the technological and/or water quality rationale for the lower limit will be part of the subcommittee's review process. An assessment is also being made of whether the fecal coliform limits for either type of reuse should be lowered.

Also under consideration is whether to include monitoring requirements or limits for some currently non-regulated contaminants such as *E. coli*. The timing on the potential rule changes has not been set.

4.4 Comparison of Texas Regulations to Other States

Reuse regulations and guidelines may specify both wastewater treatment and effluent quality limitations. Generally, the greater opportunity for direct contact between people and the reclaimed water, either through direct contact with irrigated areas or consumption of foods irrigated with reclaimed water, the more stringent the regulations.

In this section, the ranges of effluent quality limits and wastewater treatment specifications for the six states with the most stringent reuse standards for the ten types of reuse applications listed in Table 4-2 are compared to the regulations in Texas. The six states include Arizona, California, Florida, Hawaii, Nevada, and Washington. The most frequently limited parameters are biochemical oxygen demand (BOD), total suspended solids (TSS), turbidity, and total or fecal coliform.

Unrestricted Urban Reuse

In the unrestricted urban reuse regulations and guidelines, several states specify secondary treatment followed by filtration and disinfection. Nevada does not require filtration. Texas does not specify treatment requirements. For the states, BOD limits range from 5 mg/L to 30 mg/L if they are specified. Texas has the most stringent limit at 5 mg/L. Texas does not specify TSS limits but two states do at 5 and 30 mg/L. Several states limit turbidity to 2 NTU. Texas has the least stringent at 3 NTU. All states with unrestricted urban reuse regulations or guidelines limit total or fecal coliforms to non-detect or 2.2 CFUs/100 ml on average with maximums of about

25 CFUs/100 ml with the exception of Texas. Texas allows 20 CFUs/100 ml as an average with a maximum of 75 CFUs/100 ml. No other organisms are regulated in unrestricted urban reuse regulations or guidelines, but Florida requires monitoring of *Cryptosporidium* and *Giardia* downstream of disinfection, with the frequency based on treatment capacity.

Restricted Urban Reuse

Of the states specifying treatment requirements for restricted urban reuse applications, only Florida requires filtration in addition to secondary treatment and disinfection. Texas does not specify treatment requirements. BOD limits vary from 20 mg/L to 30 mg/L if they are specified. Texas has the most stringent limit at 20 mg/L. TSS limits are specified by two states at 5 and 30 mg/L. Two states limit turbidity to 2 NTU. Texas does not limit TSS or turbidity for this application. Four states with restricted urban reuse regulations or guidelines limit total or fecal coliform to approximately 25 CFUs/100 ml on average with maximums ranging from 200 to 800 CFUs/100 ml. Texas and Arizona allow 200 CFUs/100 ml as an average with a maximum of 800 CFUs/100 ml. Florida maintains more stringent limits, even for restricted urban reuse. No other organisms are regulated in restricted urban reuse regulations or guidelines, but Florida requires monitoring of *Cryptosporidium* and *Giardia* downstream of disinfection, with the frequency based on treatment capacity.

Agricultural Reuse – Food Crops

All the states allowing and specifying treatment requirements for agricultural reuse on food crops require secondary treatment, filtration, and disinfection. Texas does not specify treatment requirements. BOD limits range from 5 mg/L to 30 mg/L if they are specified. Texas does not specify TSS limits, but two states specify limits of 5 and 30 mg/L. All states specifying turbidity limits have adopted 2 NTU as the standard, except Texas, which allows 3 NTU. The Texas regulations vary depending upon whether or not the crop is irrigated directly or some form of drip irrigation is used. If the crop is to be irrigated directly, Texas requires that the BOD be 5 mg/L, which is the most stringent, and that the turbidity meet a 3 NTU, which is less stringent. In addition, the crop must be skinned or pasteurized before consumption. If the crop is not directly irrigated, the BOD can be 20 mg/L and the turbidity is not regulated.

Two states limit fecal coliform to below detection on average with a maximum of about 25 CFUs/100 ml. Three states limit total or fecal coliform to 2.2 CFUs/100 ml on average with maximums of about 25 CFUs/100 ml. Texas and Arizona allow fecal coliform of 20 and 200 CFUs/100 ml, respectively, on average with maximums of 75 and 400 CFUs/100 ml. No other organisms are restricted in agricultural reuse on food crops, but Florida requires monitoring of *Cryptosporidium* and *Giardia* downstream of disinfection with the frequency based on treatment capacity. It should be noted that agricultural reuse on food crops is illegal in some states.

Agricultural Reuse – Nonfood Crops

Many states allow and encourage agricultural reuse on nonfood crops. Of the states specifying treatment requirements for agricultural reuse on nonfood crops, only Florida requires filtration in addition to secondary treatment and disinfection. Texas does not specify treatment requirements. BOD limits range from 5 mg/L to 30 mg/L if they are specified. Texas has a limit of 20 mg/L. Texas does not specify TSS limits, but two states set limits of 20 and 30 mg/L. Two states limit turbidity to 2 NTU. Texas does not have a turbidity limit for nonfood crops. Other states do not specify turbidity limits. Total or fecal coliform limits range from 2.2 to 200 CFUs/100 ml on average with maximums ranging from 20 to 800 CFUs/100 ml. Texas requires an average of 200 CFUs/100 ml and an 800 CFUs/100 ml maximum. No other organisms are restricted.

Unrestricted Recreational Reuse

In unrestricted recreational reuse, contact with the public is likely. Of the states specifying treatment requirements for this application, only Florida requires filtration in addition to secondary treatment and disinfection. Texas does not specify treatment requirements. BOD limits range from 5 mg/L to 30 mg/L if they are specified. Texas has the most stringent limit at 5 mg/L. Texas does not specify TSS limits, but one state does at 30 mg/L. Two states limit turbidity to 2 NTU. Texas has the least stringent at 3 NTU. Other states do not specify turbidity limits. Three states with unrestricted recreation reuse regulations or guidelines limit total or fecal coliform to about 2.2 CFUs/100 ml on average with maximums of about 25 CFUs/100 ml with the exception of Texas. Texas allows 20 CFUs/100 ml as an average with a maximum of 75 CFUs/100 ml. No other organisms are restricted in restricted urban reuse regulations or guidelines, but Florida requires monitoring of *Cryptosporidium* and *Giardia* downstream of disinfection, with the frequency based on treatment capacity.

Restricted Recreational Reuse

Of the states specifying treatment requirements for restricted recreation reuse applications, only Florida and Hawaii require filtration in addition to secondary treatment and disinfection. Texas does not specify treatment requirements. BOD limits range from 20 mg/L to 30 mg/L if they are specified. Texas has the most stringent limit at 20 mg/L. Only Washington specifies TSS limits at 30 mg/L. Other states do not. Three states limit turbidity to 2 NTU. Texas does not specify turbidity limits. Four states with restricted urban reuse regulations or guidelines limit total or fecal coliform to about 2.2 CFUs/100 ml or non-detect on average with maximums of about 25 CFUs/100 ml. Texas allows 200 CFUs/100 ml as an average with a maximum of 800 CFUs/100 ml. No other organisms are restricted in restricted recreational reuse.

Environmental – Wetlands

Two states have regulations or guidelines for using reclaimed water to create constructed wetlands or enhance natural wetlands. Florida and Washington have established limits for BOD, TSS, coliforms, ammonia, and phosphorus. Texas has not included this specific use in its regulations; which would therefore; require an alternative approval from TCEQ.

Industrial Reuse

Several states have regulations for industrial reuse applications, including Texas. Regulations vary as a function of the use of the reclaimed water. Texas limits BOD to 20 mg/L, turbidity to 3 NTU, and fecal coliform to 200 CFUs/100 ml on average with a maximum of 800 CFUs/100 ml.

Groundwater Recharge

With regard to groundwater recharge, California, Florida, Hawaii, and Washington have regulations specific to groundwater recharge. Other states, including Texas, allow groundwater recharge of aquifers; however, water quality and monitoring limits are developed on a case-by-case basis. In Texas, the limits for reclaimed water recharge of the Hueco Bolson Aquifer in El Paso were based on primary and secondary drinking water standards and the California Water Factory 21 limits. Treatment requirements included advanced and tertiary treatment processes.

Indirect Potable Reuse

Indirect potable reuse can include augmentation of surface water drinking water sources or recharge of a potable aquifer either through surface spreading or direct injection into the aquifer. Regulations for this type of reuse tend to be very stringent and set on a case-by-case basis. As previously stated, the limits for reclaimed water recharge of the Hueco Bolson Aquifer in El Paso were based on primary and secondary drinking water standards and the California Water Factory 21 limits. Treatment requirements included advanced and tertiary treatment processes.

4.5 Other Areas of Requirements and Guidelines

In addition to wastewater treatment and effluent requirements, state regulations and guidelines may also address some or all of the following:

Water quality monitoring - parameters and frequency vary greatly between states and projects. The most frequently monitored parameters are those covered in the regulations and guidelines although others may be required at specific projects. Treatment facility reliability requirements vary greatly from state to state. Requirements may include redundancy, alarms, or sizes of units.

Minimum storage requirements - are set to minimize opportunities for surface discharge rather than the seasonal irrigation limitations. Requirements are highly dependent upon geographic location and climatic conditions.

Application rates - are frequently based on the hydraulic capacity of the system and are set to maximize the volume of water that can be disposed. Some states limit the nutrient loadings, particularly nitrogen.

Groundwater monitoring - many states require groundwater monitoring in areas where reclaimed water is being used for irrigation. Typical requirements are at least one monitoring well up-gradient of the reuse site and two or more down-gradient. The parameters and frequency of monitoring are generally on a case-by-case basis.

Setback distances for irrigation - are established to provide a buffer zone between reclaimed water irrigation sites and facilities such as potable water supply wells, property lines, residential areas, and roadways. These vary based on the quality of reclaimed water and the method of application.

CHAPTER 5

SUITABILITY OF CENTRAL AND SOUTHSIDE WWTP EFFLUENTS RELATIVE TO REUSE PROJECTS

5.1 Introduction

This chapter addresses the suitability of the current effluent quality from the Central and Southside wastewater treatment plants (Central and Southside) relative to the quality requirements for reclaimed water in Texas. Also, an assessment was made of the potential impact on the projected effluent quality requirements for the DWU wastewater treatment plants by implementing recycled water projects and thereby reducing effluent discharge volumes. Input to this task included more than a decade of historical effluent quality data and the results of some special testing performed by the DWU (PALS) group. The APAI team would like to acknowledge the work and contributions of Thuy Nguyen and others working with him. In addition, results from receiving water quality modeling performed during the recent preparation of discharge permit amendments were used to project future effluent quality limitations.

5.2 Assessment Approach

Assessing the suitability of the current Central and Southside effluents for recycling projects was done in a series of steps as follows:

- Identify the quality requirements for recycled water projects in Texas.
- Review the historical effluent quality at Central and Southside.
- Identify additional testing needs, if any, for the assessment.
- Perform the additional testing.
- Using the historical and project-specific data, along with the Texas water reuse criteria, assess the suitability of the current Central and Southside effluents for recycled water projects.

The second part of the evaluation presented in this section involved addressing current and projected effluent limits and how these might be affected by using Central and/or Southside effluent in recycled water projects. This assessment was done in the following way:

- Identify the current discharge quality limits.

- Using water quality modeling results from the most recent permit amendment applications, determine the projected effluent quality limitations associated with future discharge volumes.

- Using the historical effluent quality data provided by DWU, assess the plants' ability to meet the projected effluent quality limitations with current treatment processes.

- Comparing the historical data with the projected effluent quality limitations, determine the benefits of reducing the effluent discharge volume on the future effluent quality limits.

5.3 Suitability of Current Central and Southside Effluents for Recycled Water Projects

Historical Effluent Quality – Central and Southside

After identifying the water quality requirements for reclaimed water projects, effluent quality data for both Central and Southside were compiled and additional data needs were identified. Both the Central and Southside WWTPs have been awarded the Association of Metropolitan Sewerage Agencies (AMSA) Peak Performance Platinum Award. AMSA's Platinum Award recognizes agency facilities that have received Gold Awards for five consecutive years. Gold Awards honor treatment works that have achieved 100 percent compliance with their NPDES permit for an entire calendar year. Thus both Central and Southside produce high quality effluent from a TPDES permit perspective.

PALS laboratory personnel provided historical data for both Central and Southside for December 1993 through September 2003. Figure 5-1 shows the historical effluent quality for Central. Figure 5-2 shows the historical effluent quality for Southside. The historical effluent quality relative to current TPDES discharge quality permit requirements and projected requirements are discussed further in a later section of this report.

As listed in Table 4-3, the parameters of concern for reclaimed water projects include BOD, CBOD, turbidity, and fecal coliforms. The plants do not typically monitor for turbidity or fecal coliforms. Thus, additional data were needed on these parameters to assess the suitability of the plants' effluents for reclaimed water projects.

Reclaimed Water Specific Effluent Quality Testing

As discussed above, turbidity and fecal coliform data were needed to assess the suitability of the Central and Southside effluents for reclaimed water projects. DWU committed to sampling these parameters at both plants for an initial period of three months. Several other parameters were identified that would be of interest to specific potential users of recycled water. These parameters included hardness and alkalinity with calcium and magnesium and other ions that could be of interest to industrial users of recycled water. Nutrients were included for potential irrigation projects. The sampling schedule is presented in Table 5-1. Tables 5-2 and 5-3 present the results of the additional sampling that was conducted at the wastewater plants from January 2004 through March 2004.

Suitability of Central and Southside Effluent for Recycled Water Projects

The parameters of concern for reclaimed water projects in Texas from the TCEQ's perspective are CBOD or BOD, turbidity, and fecal coliforms. A review of the historical effluent CBOD data for Central and Southside and the special testing and monitoring performed specifically for this project revealed the following:

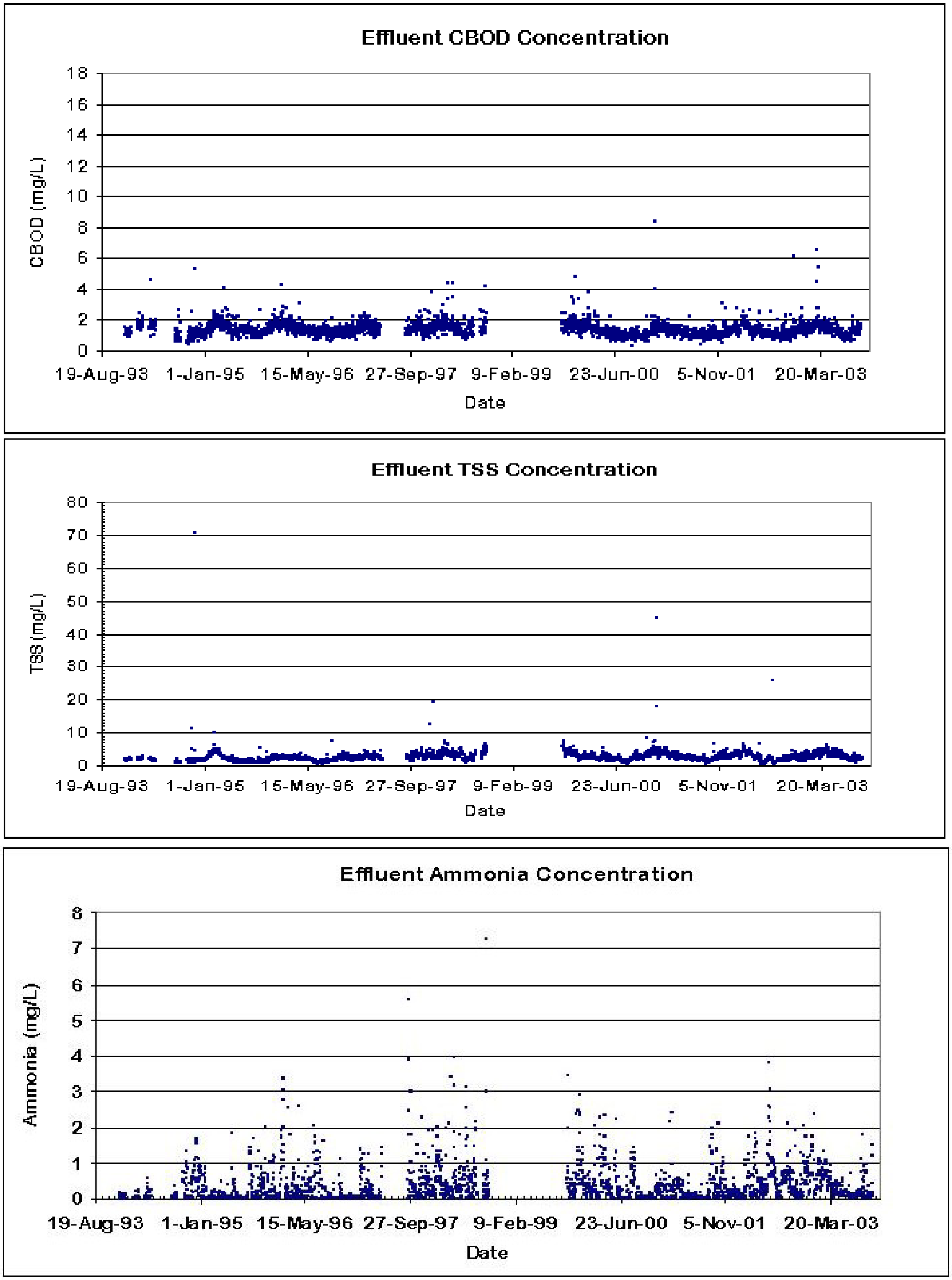
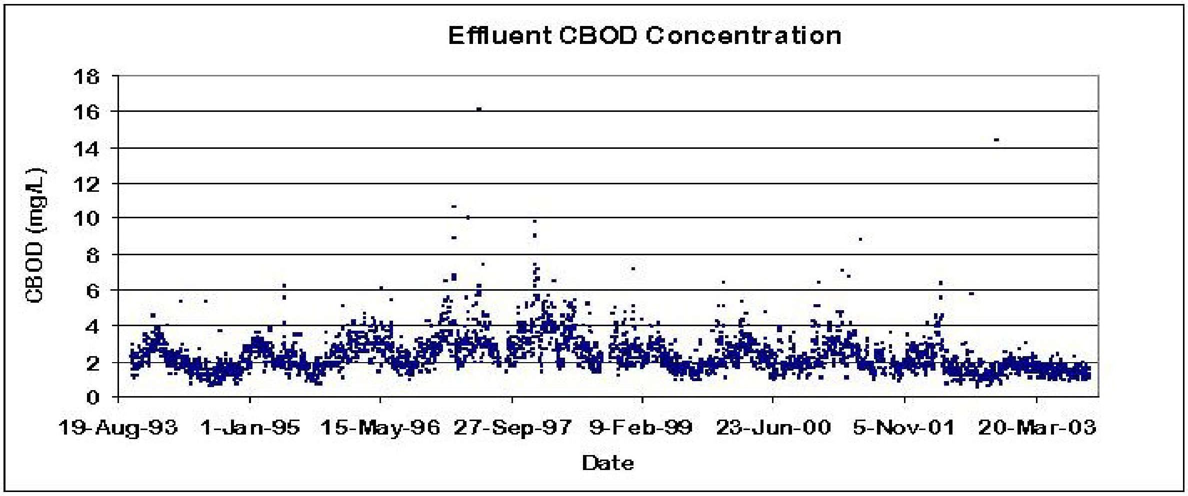
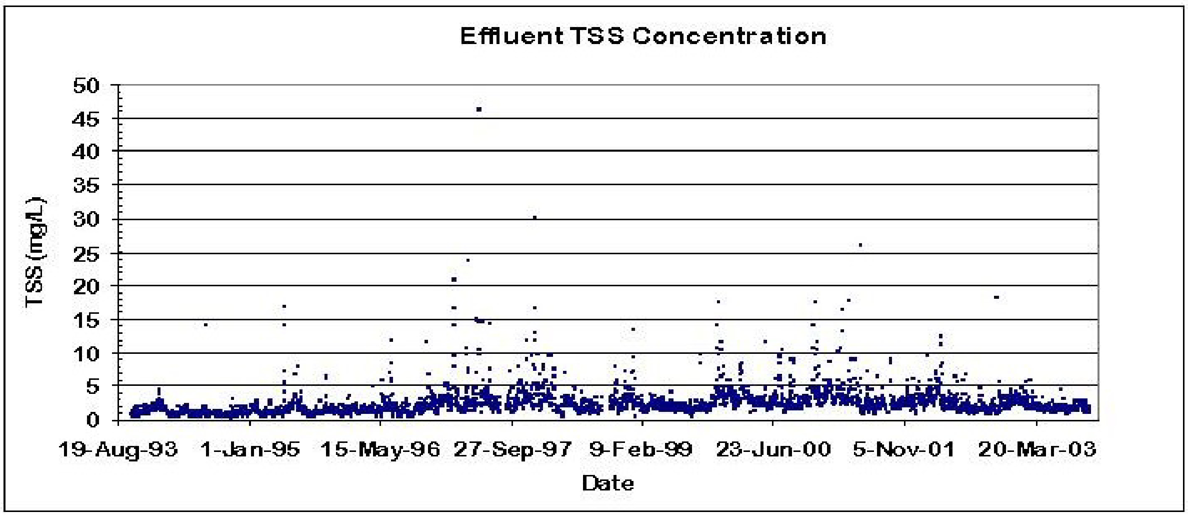


FIGURE 5-1

Dallas Central WWTP
Historical Effluent Quality – CBOD, TSS, AND NH_3





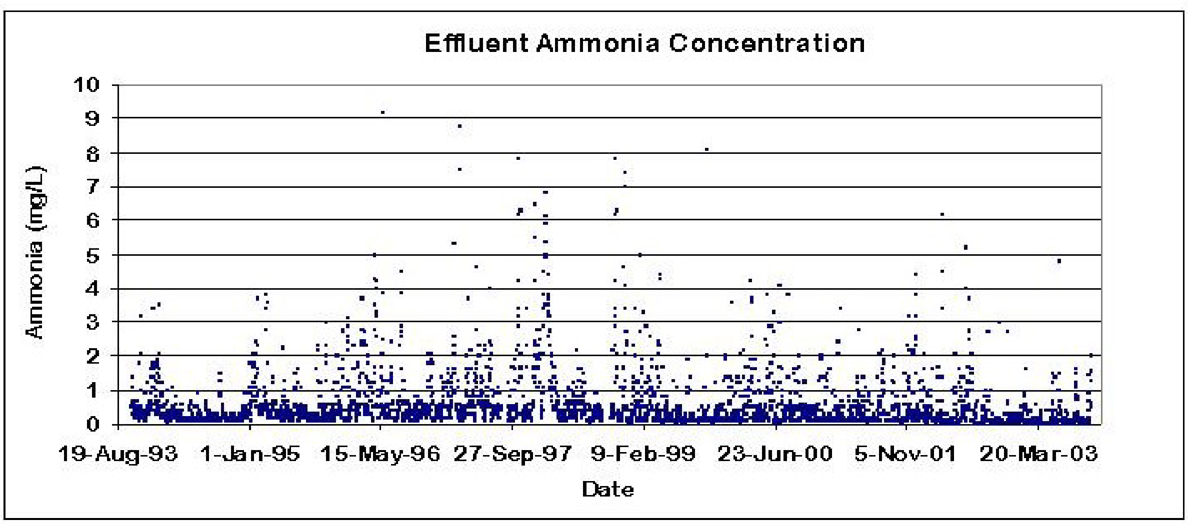


FIGURE 5-2

Dallas Southside WWTP
Historical Effluent Quality – CBOD, TSS, AND NH_3

TABLE 5-1

Sampling Schedule for January 2004 –March 2004
Dallas Water Utilities Central Wastewater Treatment Plant
and Southside Wastewater Treatment Plant

CONSTITUENT	UNITS	SAMPLE TYPE	SCHEDULE [1]
Data Required under Current Reuse			
Turbidity [2]	NTU	Grab Sample	Twice a week
Fecal Coliforms	CFU/100	Grab Sample	Twice a week
Data Needed for Specific Potential Reuse Projects			
Total Phosphorus	mg/L	24-hour Composite	Once a week
Ortho Phosphorus	mg/L	24-hour Composite	Once a week
Nitrite	mg/L	24-hour Composite	Once a week
Nitrate	mg/L	24-hour Composite	Once a week
Hardness	mg/L	24-hour Composite	Once a week
Alkalinity	mg/L	24-hour Composite	Once a week
TDS or Conductivity [3]	mg/L or µS/cm	24-hour Composite	Once a week
Sodium	mg/L	24-hour Composite	Once a week
Calcium	mg/L	24-hour Composite	Once a week
Magnesium	mg/L	24-hour Composite	Once a week
Chloride	mg/L	24-hour Composite	Once a week
Sulfate	mg/L	24-hour Composite	Once a week

Notes:
1) It will be beneficial to monitor listed constituents for a minimum of three months. Monitoring shall be conducted on the plant effluent for both the Central and Southside WWTPs.
2) Effluent TSS is currently measured daily at both WWTPs. Effluent turbidity shall be measured using the same sample that was used to measure effluent TSS. After three months of testing, a correlation between effluent TSS and turbidity can likely be developed.
3) Total dissolved solids (TDS) or conductivity shall be measured. It is not necessary to measure both constituents.

TABLE 5-2
DWU Recycled Water Implementation Plan
Effluent Sampling at Central WWTP

Central WWTP														
Parameter	Turbidity	Fecal Coliforms	O-PO4	NO2-N	NO3-N	Hardness	Alkalinity	Conduc-tivity	TDS	Na	Ca	Mg	Cl	SO4
Sample type	24hr comp	grab	24hr comp	24hr comp	24hr comp	24hr comp	24hr comp	24hr comp	24hr comp	24hr comp	24hr comp	24hr comp	24hr comp	24hr comp
Frequency	2x per week	2x per week	1x per week	1x per week	1x per week	1x per week	1x per week	1x per week	1x per week	1x per week	1x per week	1x per week	1x per week	1x per week
Unit	NTU	cfu/100mL	mg/L	mg/L	mg/L	mg/L	mg/L	mS/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Method	SM 2130B	SM 9222D	SM4500-P-E			SM2340-C	SM2320-B	SM 2510B		EPA 200.7	EPA 200.7	EPA 200.7	4500-Cl-B	SM4500-SO4-D
01/13/04	1.6	<10	3.37	0.02	16.2		30.0			68.2	40.0	5.04		110
01/15/04	2.2	<10		0.01	17.3	172.5	34.3						130	
01/20/04	2.6	<10	1.60	0.00	13.5	166.2	103.7			47.2	108	3.92	68	140
01/22/04	2.2	<10						630						
01/27/04	1.5	<10	3.20	0.00	15.4	212.5	54.6	543		70.0	52.5	4.77	79	122
01/29/04	2.0	<10						495						
02/03/04	1.3	<10	2.84	0.02	15.3	201.2	49.1	495		71.7	52.8	5.04	75	113
02/05/04	1.8	<10						460						
02/10/04	2.1	<10	2.59	0.04	14.8	205		490		66.7	64.4	4.91	71	120
02/12/04	1.7	<10						468						
02/17/04	1.7	<10	1.42	0.00	12.5	200	85	561		61.1	71.1	4.87	74	
02/19/04	1.8	<10						560						
02/24/04	2.0	<10	2.13	0.06	9.4		50	510		70.5	57.2	5.15	57	
03/02/04	2.3	<10	1.95	0.00	10.8	234	95	610					67	117
03/04/04	2.2	<10						605						
03/09/04	0.7	<10	2.66	0.03	12.6		110	735						121
03/11/04	1.3	<10				208	86	623						
03/16/04	1.8	<10	1.95	0.02	13.4	217	85	636						110
03/18/04	1.2	<10						567						
03/23/04	1.0	<10	3.90	0.00	16.3	180	58							110
03/25/04	1.8	<10												
03/30/04	1.4		1.81	0.05	17.7	183	48							117

TABLE 5-3
DWU Recycled Water Implementation Plan
Effluent Sampling at Southside WWTP

Southside WWTP														
Parameter	Turbidity	Fecal Coliforms	O-PO4	NO2-N	NO3-N	Hardness	Alkalinity	Conduc-tivity	TDS	Na	Ca	Mg	Cl	SO4
Sample type	24hr comp	grab	24hr comp	24hr comp	24hr comp	24hr comp	24hr comp	24hr comp	24hr comp	24hr comp	24hr comp	24hr comp	24hr comp	24hr comp
Frequency	2x per week	2x per week	1x per week	1x per week	1x per week	1x per week	1x per week	1x per week	1x per week	1x per week	1x per week	1x per week	1x per week	1x per week
Unit	NTU	cfu/100mL	mg/L	mg/L	mg/L	mg/L	mg/L	□S/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Method	SM 2130B	SM 9222D	SM4500-P-E			SM2340-C	SM2320-B	SM 2510B		EPA 200.7	EPA 200.7	EPA 200.7	4500-Cl-B	SM4500-SO4-D
01/13/04	2.2	<10					65	650		81	41.3	4.54	61.4	110
01/15/04	1.0	<10					61	700					61.6	
01/20/04	2.0	<10			7.7		109	700		54.8	79.2	3.96	47.3	126
01/22/04	1.5	<10					99	700					51.8	
01/27/04	1.0	<10			7.7		96	750		75.4	56.1	4.63	55.5	124
01/29/04	1.0	<10					83	700					58.1	
02/03/04	1.5	<10	3.62		8.1		86	700		81.6	52.5	4.51	58.6	130
02/05/04		<10					78						57.6	
02/10/04	1.0	<10			7.3		109	750		75.8	66.9	4.73	55.1	130
02/12/04	1.5	<10					100	750					56.7	
02/17/04	1.5	<10	2.31			190	125	750	501	63.2	71.3	4.58	51.8	
02/19/04	2.0	<10					112	700					54.1	
02/24/04	1.0	<10	3.44	0.08	12.7	227	104	750	528	78.1	61.4	5.5	52.9	106
03/02/04	1.5	<10	1.95	0.00	6.6	237	138	750	482				45.3	104
03/04/04	1.5	<10					140	750	465				48.0	
03/09/04	1.5	<10	2.06	0.00	6.2	245	126	800	463				51.0	114
03/11/04	1.0	<10				234	130	750	504					
03/16/04		<10	0.99	0.02	6.3	218			482				50.7	63
03/18/04		<10							464				54.4	
03/23/04	1.0	<10	3.2	0.03	7.4		105	800	497				56.0	113
03/25/04		<10				200			480				61.9	
03/30/04	2.0		0.39	0.05	7.5	217	101	700					60.4	130

- At Central, none of the monthly averages exceeded the TCEQ reclaimed water quality limit of 15 mg/L for Type II reclaimed water projects or the 5 mg/L CBOD limit for Type I reclaimed water projects. On only five days out of approximately 3650 did the daily CBOD value exceed the Type I limit, and there were no exceedences of the Type II limits.

- At Southside, none of the monthly averages exceeded the TCEQ reclaimed water quality limit of 15 mg/L for Type II reclaimed water projects or the 5 mg/L CBOD limit for Type I reclaimed water projects. On only 12 days out of approximately 3650 did the daily CBOD value exceed the Type I limit, and there was only one exceedence of the 15 mg/L CBOD limit for Type II reclaimed water projects. The one exceedence was a value of 16 mg/L.

- None of the coliform samples from either plant produced more than 10 colonies per 100 mL. All values were thus significantly below the Type I limit of 20 CFUs/100 mL and the higher Type II limit.

The effluent turbidity averaged less than 1.7 NTU at both plants, which is lower than the current limit of 3 NTU for Type I reclaimed water projects. It is also lower than the lower limit of 2 NTU being considered by the committee revising the reclaimed water regulations.

Based on these results, both Central and Southside are producing effluents that are suitable for either Type I or Type II reclaimed water projects. It should be noted, however, that neither plant is loaded to its rated capacity. As the plant processes approach their design capacity, it may become more difficult to consistently produce such low concentrations of CBOD or low levels of turbidity. These parameters should continue to be monitored and any increasing trends noted and addressed. With regard to the turbidity and fecal coliform data, the database evaluated included only three months of plant operation.

DWU has committed to continue monitoring turbidity and fecal coliforms and the other constituents identified in Table 5-1 on a weekly basis at both plants. There are no specific criteria for evaluating the other constituents being monitored at this time. They do, however, provide valuable information that will be used by potential recycled water customers. For example, the TDS and its various components will be of interest in potential cooling water supplies. Irrigation or landscaping projects will require information on the nutrients in the effluent in addition to sodium and chlorides. The ionic distribution will also be of interest to electronics manufacturers who might consider the use of recycled water for the industrial water supply.

5.4 Projected Effluent Quality Permit Issues

DWU is currently authorized to discharge from Central and Southside under TPDES Permits Nos. 10060-001 and 10060-006, respectively. Table 5-4 presents the current discharge quality limits. Central's discharge permit expires December 1, 2006. Southside's permit expired December 1, 2002. A permit amendment application was submitted in 2002 for Southside; however, a new permit has not yet been issued due to issues related to the discharge quality limits.

TABLE 5-4

Wastewater Treatment Plant Discharge Permit Requirements
Dallas Water Utilities Central Wastewater Treatment Plant
and Southside Wastewater Treatment Plant

Wastewater Treatment Plant	Summer/Spring Effluent Limits ($CBOD/TSS/NH_3$-N/DO) (mg/L)	Winter Effluent Limits ($CBOD/TSS/NH_3$-N/DO) (mg/l)
Central (10060-001)	7 / 15 / 2 / 5	7 / 15 / 4 / 5
Southside (10060-006)	7 / 15 / 3* / 5	7 / 15 / 4 / 5

* Under review. Ammonia limits may be reduced in new permit.

Factors Affecting Future Effluent Requirements

There are a number of factors that will influence the future effluent limits for Central and Southside, including but not limited to the following:

- The assimilative capacity of the upper Trinity River system into which the plants discharge.
- The competing loads from other dischargers into the upper Trinity River system.
- The location of the discharges – advective streams such as the Trinity River vs. lake systems such as Lake Ray Hubbard.
- Downstream raw water supplies.
- Reclaimed (recycled) water uses.

Assimilative Capacity and Competing Loads

A number of large plants discharge into the upper Trinity River system including: Fort Worth Village Creek WWTP, Trinity River Authority (TRA) Central Regional WWTP, Dallas Central WWTP, Dallas Southside WWTP, and TRA Ten Mile Creek Regional WWTP. In addition, two Garland WWTPs (Rowlett Creek and Duck Creek) and one NTMWD WWTP (South Mesquite Creek) discharge into the East Fork of the Trinity River and impact the assimilative capacity of the upper Trinity River system. The major dischargers to the upper Trinity River have summer effluent limits of 7 mg/L CBOD, 15 mg/L TSS, 2 or 3 mg/L ammonia, and 4 to 6 mg/L dissolved oxygen (DO).

Currently, the Upper Trinity River Compact (Fort Worth, TRA, Dallas, and NTMWD) and the TCEQ are evaluating what future combinations of discharge flows will allow their WWTPs to continue at their present effluent limits. However, if discharge flows continue to increase for the upper Trinity River during the next 10 to 20 years, the effluent limits will need to become more restricted. Appropriate effluent limits during the summer may be in the range of 5 mg/L CBOD, 5 mg/L TSS, 1 to 2 mg/L ammonia, and 5 to 6 mg/L DO.

Thus, for the immediate future, the effluent limits for CBOD, TSS, ammonia, and DO should remain about the same as they are currently for the major dischargers to the upper Trinity River. As the discharge flows increase substantially, these limits will become more restrictive. Reducing effluent flows by recycling water could help sustain the current effluent limits for additional years.

Discharge Location and Potential Nutrient Limits

Lakes and advective streams and rivers respond differently to waste loads. In lakes, there is less flushing and transport of the loads out of the system. A major concern in lake systems is nutrient loadings. Nutrients such as nitrogen and phosphorus can increase the growth of algae and lead to excessive eutrophication of the lake. Currently, total nitrogen and phosphorus are not limited in most discharge permits in Texas. However, based on proposed regulations and guidance from the EPA and discussions with the TCEQ, it appears that nutrient removal will eventually be required.

The TCEQ has indicated that the first WWTPs to receive nutrient limits in their permits will be those that discharge into reservoirs used as drinking water supplies or into streams or rivers just above drinking water reservoirs. It is unclear at this time what the future nutrient limits will be or when they will go into effect, but phosphorus will likely be the first nutrient requiring removal. For those permittees with phosphorus limits, the limit has historically been 1 mg/L. However, the NTMWD Wilson Creek plant received a phosphorus limit of 0.5 mg/L for its discharge into Lake Lavon. Some TCEQ personnel have indicated that phosphorus limits for wastewater discharges could go even lower in the future. It is likely that dischargers into lakes will receive phosphorus limits of 0.5 to 1.0 mg/L. For phosphorus limits down to 1.0 mg/L, biological nutrient removal processes can be used with chemical addition as an infrequent backup. For phosphorus limits below 1.0 mg/L, chemical addition is required in addition to biological nutrient removal to consistently meet the limit.

With regard to nitrogen, water quality modeling does not clearly support the need for nitrogen removal. However, there is a national trend to include total nitrogen limits in permits, and it is likely that Texas will begin within the next decade. A total nitrogen limit is different from an ammonia limit. Ammonia nitrogen is an oxygen-consuming load when discharged to lakes or streams and rivers. It is limited to minimize the drop in DO. The reduction of ammonia in wastewater is referred to as nitrification. In the nitrification process, ammonia is transformed to nitrates. Nitrification requirements have been in permits for several decades and will continue. All of the major plants discharging into the upper Trinity River consistently meet their nitrification limits.

The total nitrogen limits being discussed address the removal of nitrogen – particularly in the form of nitrates from discharges. It is not clear what the total nitrogen limits will be. They will probably fall in the 4 to 10 mg/L range. For total nitrogen limits down to about 10 mg/L, biological denitrification processes can be used. For limits less than 10 mg/L, some type of denitrifying filter with methanol addition may be required. There are biological nutrient removal systems that do produce effluents of less than 10 mg/L, however, for the lower limits, additional treatment capability is prudent.

Use of Reclaimed Water

When DWU implements recycled water projects, the TCEQ requirements for reclaimed water will be applied even though the permit would not have to be changed to reflect the requirements. As discussed in an earlier section of this report, the primary parameters of concern for reclaimed water projects include BOD/CBOD, turbidity, and fecal coliform. Both Central's and Southside's current treatment processes are capable of meeting this limit; however, as the plant flows increase toward the design capacity, some additional treatment capacity may be required. The plants are currently meeting both the existing turbidity limit of 3 NTUs and the potential limit of 2 NTUs for Type I reclaimed water projects. As loadings on the plant increase, additional filtration capacity may be required. Chlorine disinfection systems such as the ones at Central and Southside are typically adequate for treating the fecal coliform limit for reclaimed water projects.

New Federal and State Regulations

It is difficult to predict what new federal or state requirements may be applied to discharge permits in the future. As plants move into more recycled water projects, total dissolved solids (TDS) levels may become an issue, and there are some permits with TDS limits in them at this time. The removal of TDS can require advanced treatment processes such as reverse osmosis. With water augmentation projects (use of reclaimed water to augment raw water supplies) increasing, more stringent microbial limits (e.g., *E. coli*) may be applied to wastewater discharge permits.

While endocrine disruptors (EDs) and pharmaceutically active compounds (PACs) have not been demonstrated to pose a threat to humans, they have been shown to have a negative impact on the biota in receiving waters. Limits may be set on some of these substances. The processes required to remove the compounds will depend on which compounds are limited. Some of the compounds are removed through enhanced activated sludge processes (longer hydraulic detention times and higher sludge ages), others may require advanced oxidation (UV peroxide) or membrane processes to remove. The action levels of these compounds are in the parts per trillion range and are thus difficult to measure and may be difficult to remove.

Potential Future Effluent Requirements

As discussed, there are many factors that could impact the future permit limits for Central and Southside. Based on the information presented above, the following discharge scenarios are likely but by no means certain:

1. Existing outfall at flows less than those projected for 2020, no recycled water projects.

    a. CBOD = 7 mg/L
    b. TSS = 15 mg/L
    c. Ammonia Nitrogen = 2 or 3 mg/L
    d. Dissolved oxygen = 5 mg/L
    e. Phosphorus = 1 mg/L (future)

2. Existing outfalls at flows greater than those projected for 2020, no recycled water projects.

    a. CBOD = 5 mg/L
    b. TSS = 5 mg/L
    c. Ammonia Nitrogen = 1 to 2 mg/L
    d. Dissolved oxygen = 6 mg/L
    e. Phosphorus = 0.5 mg/L (future)
    f. Total Nitrogen = 4 to 10 mg/L (future)

3. Type I reclaimed water (not a permit limit but required for reclaimed water).

    a. CBOD = 5 mg/L
    b. TSS = 2 or 3 mg/L (at this level, essentially equivalent to turbidity)
    c. Ammonia Nitrogen = 2 or 3 mg/L
    d. Fecal coliforms = less than 20 CFUs/100 mL
    e. Phosphorus = 0.5 mg/L (future, more likely with augmentation)
    f. Total Nitrogen = 4 to 10 mg/L (future)

4. Type II reclaimed water (not a permit limit, but required for reclaimed water).

    a. CBOD = 7 mg/L
    b. TSS = 15 mg/L (current permit limit)
    c. Ammonia Nitrogen = 2 or 3 mg/L
    d. Fecal coliforms = less than 20 CFUs/100 mL
    e. Phosphorus = 0.5 mg/L (future, more likely with augmentation)
    f. Total Nitrogen = 4 to 10 mg/L (future)

Capability of Existing Plants to Meet the Projected Limits

With regard to the ability of Central and Southside to meet the current and projected effluent limits without recycled water projects or nutrient limits, both plants have clearly demonstrated their ability to do so. Figures 5-3 and 5-4 present the daily effluent values for CBOD, TSS, and ammonia nitrogen for Central and Southside, respectively, relative to the current and projected 30-day limits. The daily values rarely exceed the 30-day average limits; consequently, the 30-day averages would also not exceed the limits. The most vulnerable area in meeting projected effluent limits for the key parameters shown is probably the Southside ammonia limit. However, modifications being made in the secondary biological treatment system will reduce this vulnerability.

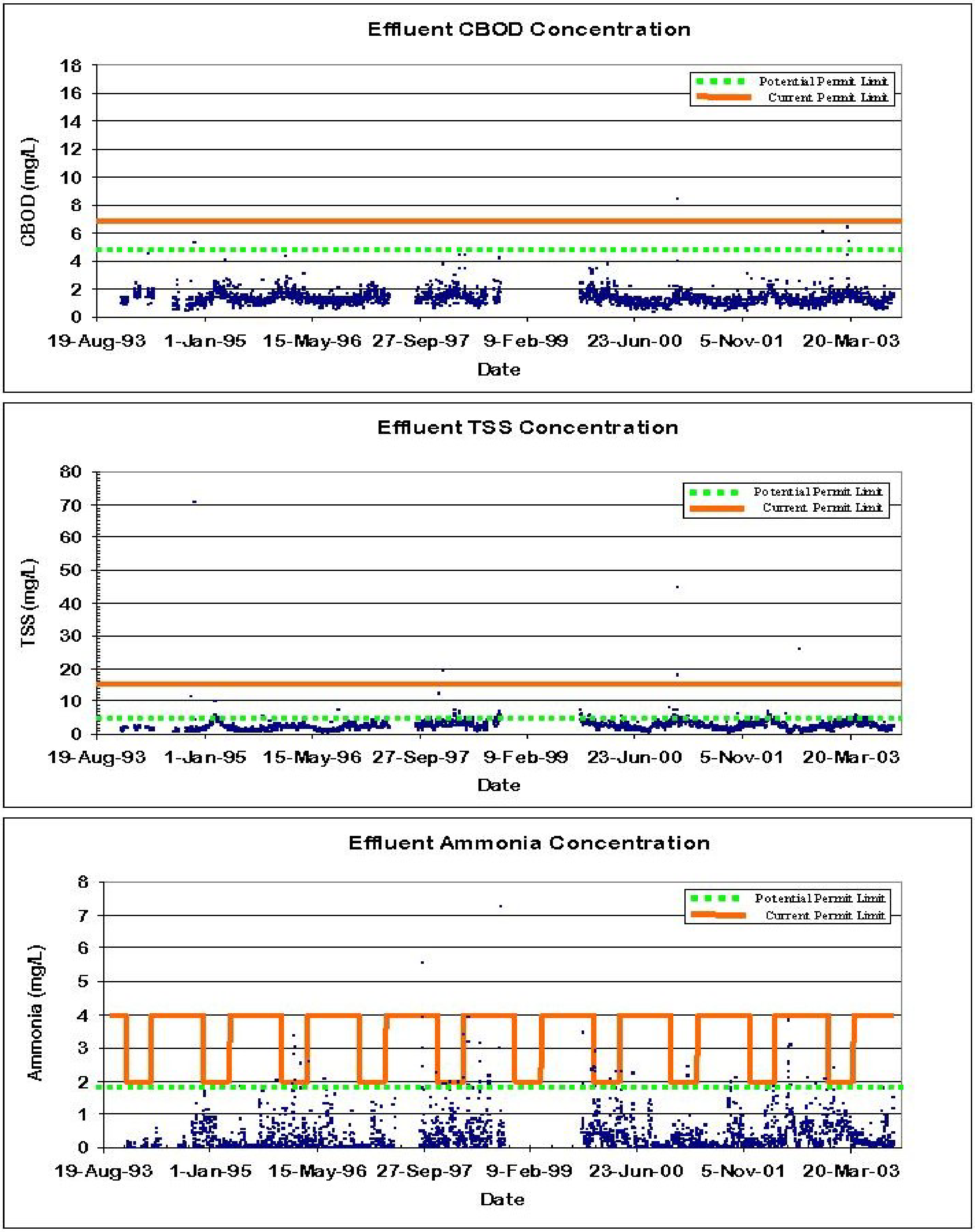
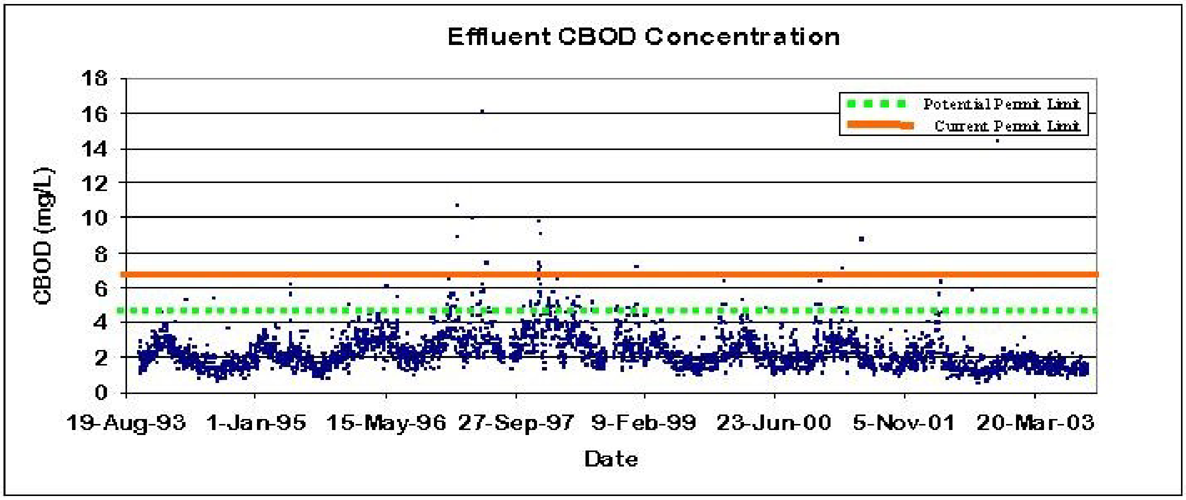
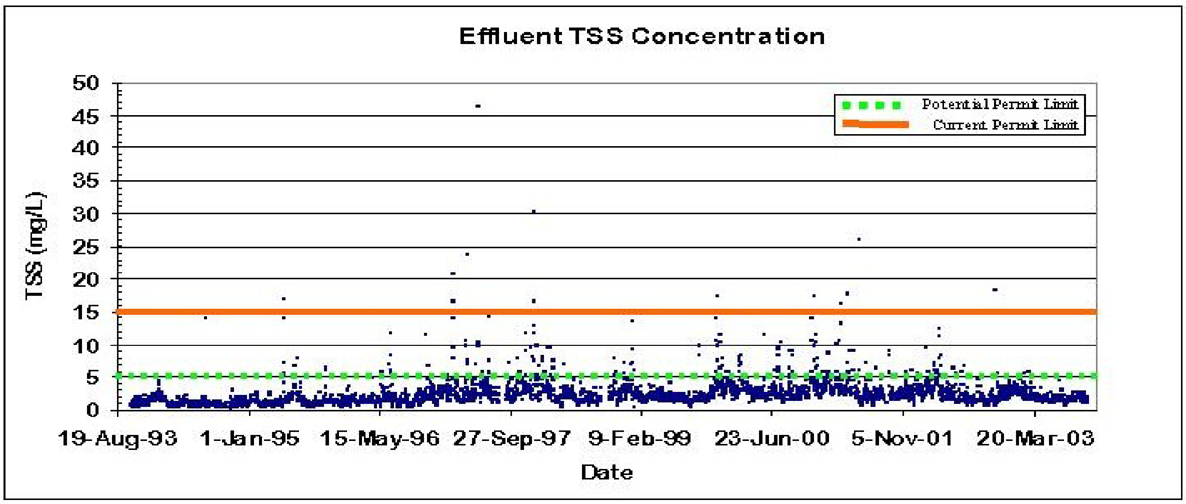


FIGURE 5-3
Dallas Central WWTP
Historical and Projected Permit Compliance
CBOD, TSS, and NH_3

(This page intentionally left blank.)





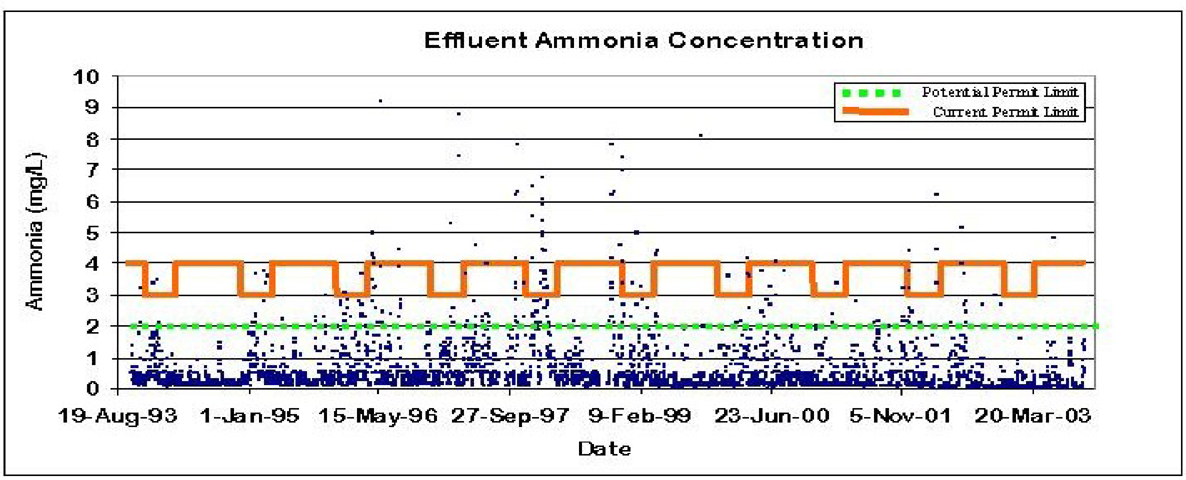


FIGURE 5-4
Dallas Southside WWTP
Historical and Projected Permit Compliance
CBOD, TSS, and NH_3

(This page intentionally left blank.).

Neither of the plants is designed for nutrient removal. The aeration systems of either could be modified for biological nutrient removal – either nitrogen or phosphorus removal or both. Depending on the actual limits imposed, additional chemical treatment or denitrifying filters could be required.

With regard to meeting the reclaimed water limits imposed by the TCEQ, both plants have demonstrated their ability to meet the quality requirements. As the plants' flows increase and approach the rated design capacities of the plants, careful observations should be made of the CBOD and turbidity levels. Any trends of increased CBOD and turbidity levels should be addressed, possibly with additional treatment capacity. At this time, the effluents from either plant could be used for Type I or Type II reclaimed water.

5.5 Potential Recycled Water Uses

Recycled water refers to the application of treated wastewater for beneficial purposes such as agricultural and landscape irrigation, industrial processes, toilet flushing, etc. Recycled water has also been successfully used as a water supply alternative in various indirect or direct applications to augment raw water supplies.

As populations and water demands grow, the uses of recycled water increase rapidly. The environmental benefits of the use of recycled water include:

- Extending useful life of water supplies by providing an additional water source for non-consumptive water needs;
- Reducing stress on raw water sources during dry-weather periods;
- Decreasing wastewater discharges;
- Reducing and preventing pollution; and
- Creating or enhancing wetlands and riparian habitats.

Table 5-5 provides a summary of potential recycled water and user categories and water uses.

TABLE 5-5

Dallas Water Utilities Recycled Water Implementation Plan
Potential Recycled Water End User Categories and Water Uses

Potential Recycled Water End User Categories	***Potential Uses of Recycled Water***
Construction	Dust control, soil compaction
Food Production	Indirect irrigation of food crops that will be peeled, skinned, cooked, or thermally processed
Hospitals	Cooling water, landscape irrigation
Hotels	Cooling water, landscape irrigation
Irrigation	Irrigation of animal feed crops other than pastures for milking animals, sod farms
Manufacturing	Process water, landscape irrigation, cooling water, dust control
Office Buildings	Cooling water, landscape irrigation
Power Generation	Cooling water
Residential	Landscape irrigation, toilet flushing
Service Industry	Irrigation of parks, golf courses, maintenance of restricted recreation impoundments, silviculture, highway medians, raw water augmentation

Initially, the recycled water use options identified as potentially applicable to the Dallas Recycled Water Program included:

- Irrigation of residences
- Irrigation of golf courses
- Irrigation of parks and other public access areas
- Commercial and industrial water uses
- Cooling water
- Water supply augmentation
- Indirect potable reuse
- Specific options
  - Irrigation at Dallas Zoo
  - Texas Instruments
  - Southside Wastewater Treatment Plant energy recovery cooling water
  - Water supply and flushing for Trinity River Projects lakes and subsequent irrigation projects using the lakes as a source of water.

Based on discussions with the City, initial focus for uses of recycled water by the City of Dallas will be Type II applications. Type II recycled water can be used in instances where incidental contact with humans is not likely to occur. Type II applications include:

- Irrigation of restricted areas, such as golf courses, sod farms, silviculture, or highway rights-of-way.

- Indirect irrigation of food crops that will be peeled, skinned, cooked, or thermally processed.

- Irrigation of animal feed crops other than pastures for milking animals.

- Maintenance of restricted recreational impoundments.

- Soil compaction or dust control in construction activities.

- Cooling tower make-up water.

- Nonpotable uses at wastewater treatment plants.

- Other similar activities where the potential for unintentional human exposure is not likely.

- Water supply and flushing of Trinity River project lakes and irrigation projects associated with the lakes.

As a result of this initial focus on Type II applications, irrigation of residences and indirect potable reuse have been excluded from this analysis. The evaluation of raw water supply augmentation has been expanded and is addressed in Volume 2 of this report.

CHAPTER 6

STATE AND NATIONAL RECYCLED WATER PROGRAMS

6.1 Introduction

As new water resources become more difficult and expensive to develop, more and more communities are studying, contemplating, and/or implementing recycled water projects for the following reasons:

- Increasing demand for water due to population growth and/or economic development.
- Limited available water resources.
- Difficulty of obtaining or developing new water resources.
- Increasingly more restrictive discharge standards.
- Pollution abatement/economics.

By reviewing the experience, challenges faced, and obstacles overcome by others in developing and implementing recycled water programs, DWU can gain insight into the issues that should be considered and addressed. This chapter of the report briefly reviews representative recycled water projects in Texas and throughout the United States. Projects reviewed include the following:

- Texas Programs
  - El Paso, Texas
  - Odessa, Texas
  - Tarrant Regional Water District (TRWD) Wetland

- National Programs
  - Scottsdale, Arizona
  - San Diego, California
  - Tampa, Florida
  - Denver, Colorado
  - Clayton County, Georgia, Wetland

6.2 State and National Recycled Water Programs

Table 6-1 provides each project name, recycled water application, overall description, regulatory, public and other implementation issues and challenges, costing/pricing, implementation status, and insights for DWU. More detailed narratives on each recycled water project are presented after the table.

(This page intentionally left blank.)

TABLE 6-1
DWU Recycled Water Implementation Plan
Summary Table for Texas and National Recycle Water Programs

PROJECT	APPLICATION	DESCRIPTION	IMPLEMENTATION ISSUES AND CHALLENGES			COST/ PRICING	STATUS	INSIGHTS FOR DWU
			REGULATORY	PUBLIC	OTHER			
El Paso, TX *Hueco Bolson Recharge Project* and other reclaimed water projects	• Direct aquifer recharge • Industrial supply • Landscape irrigation	El Paso has four wastewater reclamation plants. Fred Harvey WWTP treats to drinking water standards. The three other advanced secondary WWTPs treat to Type I reuse standards.	• No national or state regulations or guidelines for direct recharge • Used national and state primary drinking water standards • Considered CA Water Factory 21 requirements	• Water shortages increased public awareness of need for reuse • City emphasis on conservation important to success • Public announcements made regarding recharge	• Problems with injection well corrosion and plugging have been resolved	• Funding included grants from TWDB, US Bureau of Reclamation, US Economic Dev. Board, and revenue bonds from City of El Paso. • Type I sold at 60% of potable cost = $0.56/ccf • Tertiary water sold at 80% of potable cost = $0.75/ccf	Active since 1984 and continuing to expand.	• Federal and state funding may be available. • Public education critical for cooperation and acceptance. • Recycle water viable for augmenting potable water sources.
Odessa, TX	• Industrial supply • Landscape irrigation • Dual water service (new development area)	Bob Derrington WWTP provides both Type I and Type II effluent quality for different users.	• City was required to limit WW discharges in its permit	• City is reviewing how to provide water when all water is contractually obligated • Not enough reuse water to meet demand	• There are environmental implications associated with eliminating discharge of the effluent into the receiving stream	• Rates were originally set in contracts with the initial large users and have not been changed • Current rate for residential irrigation is $0.60 / 1000 gals. • Current rate for new industrial users is $0.86 / 1000 gals.	Active since 1949 (additional agricultural, industrial and aquifer recharge users identified in 1985 and 1987) and continuing to mature. Currently reusing ~ 75% of effluent, up to 6.0 MGD	• When water resources become tight, recycled water will become a valuable and indispensable resource and there may not be enough for all identified users.
Tarrant Regional Water District	• Augment water supply (Richland-Chambers Reservoir)	Constructed wetlands project designed to treat water diverted from the Trinity River (comprised mostly of WWTP effluent and storm water runoff).	• Water rights permitting was a significant obstacle to diverting water from the Trinity River • Maximum blend rate for drinking water reservoir was not established	• Overall water quality improvement feasible through the use of a constructed wetland	• Long term ability for phosphorus and nitrogen removal and retention in a constructed wetland • Performance of plant species • Operational requirements for effective nutrient and contaminant removal	• Separate rate not established as recycle water will be merely an additional source of water for the District	Pilot scale wetland operating since 1993. Field scale wetland with a capacity up to 12 MGD was recently put into operation. Wetland effluent is currently returned to the Trinity River. A decision should be made in a few years to convey the recycled water to the Richland-Chambers Reservoir and expand the wetland system.	• Pilot and field scale projects have demonstrated the ability of a constructed wetland system to process an effluent dominated flow to a quality suitable for indirect potable water reuse. • Water rights issues can be significant obstacle
Scottsdale, AR *Water Campus*	• Landscape irrigation • Direct aquifer recharge	Water Campus provides two levels of treatment. One plant treats wastewater to acceptable irrigation-quality recycle water. An advanced water treatment facility further treats WRP effluent with disinfection, MF, and RO prior to injection as recharge into the local aquifer.	• Water campus is a key contributor to Scottsdale's compliance with Arizona's 1980 Groundwater Management Act and assurance of a 100-yr Adequate and Assured Water Supply required by the Arizona Dept. of Water Resources • Based on reuse availability, Scottsdale requires golf courses to give their water rights to the City	• Public meetings were held to gather public input and concerns • A quarterly newsletter was mailed to all City residents • More than 600 residents attended the plant dedication that included tours and displays	• Water Campus is the first permitted facility in Arizona and currently one of the largest in the nation to treat wastewater to drinking water standards with MF and RO • MF had never before been applied to the pretreatment of wastewater prior to RO • Water Campus is the first large facility to use thin film composite RO membranes	• City spends approximately $1 to treat 1,000 gallons of recycle water not including capital or membrane replacement costs • Recycle water is sold between $0.30 and $0.90 / 1,000 gals. depending on the pumping requirements	Water campus has been in continuous operation since the mid 1990's. The Water Reclamation Plant expansion to 16 MGD and the Advanced Water Treatment facility expansion to 16 MGD should both be complete in mid 2006.	• Water Campus demonstrates that the use of recycle water for recharge of a drinking water aquifer (indirect potable water reuse) is viable. • The aesthetically pleasing design and a concerted effort to gather public input resulted in high public support for the project.

(This page intentionally left blank.)

TABLE 6-1
DWU Recycled Water Implementation Plan
Summary Table for Texas and National Recycle Water Programs

PROJECT	APPLICATION	DESCRIPTION	IMPLEMENTATION ISSUES AND CHALLENGES			COST/ PRICING	STATUS	INSIGHTS FOR DWU
			REGULATORY	PUBLIC	OTHER			
San Diego, CA	• Demonstrate effectiveness and reliability of a recycle water treatment train • Examine health effects of using highly treated recycle water as a raw water source	San Diego Total Resource Recovery Project consists of three research projects: Aqua I (RO pilot plant), Aqua II (0.3 MGD aquatic treatment pond and advanced WTP), and Aqua III (1.2 MGD water hyacinth process plant and 0.5 MGD packaged advanced WTP)	• San Diego County Water Authority, the lead agency, worked with many local, state, and federal agencies to identify design constraints, regulatory requirements, and obtain project approval and permitting	• Public outreach was implemented, but not totally effective. • Some of the public felt that effluent from wealthier parts of the city would be treated and distributed to poorer areas • Opponents of the program dubbed the effort "Toilet to Tap"		• Federal grants through the Federal Water Pollution Control Grant Program were used as partial funding for Aqua II and Aqua III. The remaining funding was provided by the City of San Diego.	Collection of health effects data at Aqua III was completed in 1995. Project was ended in 1998 due to public perception and politics.	• Aqua II demonstrated that rotary disk filters were sufficient primary treatment ahead of aquatic secondary systems. • While land intensive, hyacinth process provides satisfactory level of secondary treatment. Fouling of the polyamide membrane by organic acids from the hyacinth process could be reduced or eliminated with lime stabilization coagulation and sedimentation followed by cellulose acetate membranes. • Public perception and political acceptance are critical to success.
Tampa, FL	• Augment water supply	In 1983, Tampa implemented a pilot study to investigate the feasibility of using effluent from the Howard F. Current advanced WWTP to augment water supply. The 50 gpm pilot plant included preaeration, lime treatment, recarbonation, gravity filtration, and ozone disinfection. GAC, RO and UF were also evaluated	• The State of Florida Department of Environmental Resources has regulations addressing indirect potable reuse. The Tampa Water Resource Recovery Project would have met all DEP treatment and quality requirements	• Public was concerned about potential adverse health effects associated with the ingestion of recycle water derived from treated wastewater. • Opposition from water purveyors encountered.		• Project had secured funding from the USEPA, the Southwest Florida Water Management District, the City of Tampa and the West Coast Regional Water District for a three-phased implementation plan with incremental plant capacities of 15, 35 and 50 MGD	The project has been terminated due to lack of acceptance related to health concerns.	• Production of recycle water that is acceptable as a raw water source is technically feasible with common water treatment technology. • Recycle water produced with supplemental treatment (including GAC and ozone) has not been shown to present a significant microbial or toxicological risk. • Public acceptance is conditional, sometimes emotional, and requires a significant and politically sensitive education program. • Estimated cost of recycle water was found to be greater than the cost of traditional water supplies.
Denver, CO	• Create potable water supply that could be delivered directly to the customer	Denver Potable Reuse Demonstration Project consisted of a 1.0 MGD recycle WTP located at the existing Denver Metropolitan Regional Wastewater Facility. The advanced treatment plant includes chemical treatment, filtration, UV, GAC, RO, air stripping, ozonation, chloramination, UF sidestream		• Proving the ability and reliability of the treatment technology to consistently and continuously produce drinking water from treated wastewater effluent • Public outcry killed the project just before it was scheduled to be funded	• A multiple barrier approach was used to produce a highly reliable process in which no one process was entirely responsible for the removal of a given contaminant. • With the exception of air stripping, equipment redundancy was incorporated in all of the treatment processes.		The multiple barrier design and reliability components allowed the demonstration plant to consistently produce potable water from secondary treated wastewater. Implementation of a full-scale recycle water project has not been initiated and there are no plans to implement a direct potable reuse project in Denver.	• Denver demonstrated that secondary treated wastewater could be reliably processed to meet or exceed drinking water standards without any detected adverse health effects. • Public acceptance can be a significant obstacle
Clayton Cty, GA	• Discharge cleaner water into area streams • Augment water supply through discharge into one of the County's secondary water reservoirs	The Huie Land Management site has historically been used as a land application system to treat effluent from two WWTPs. A portion of the Huie Land Management site has been converted to a constructed wetland system. Ultimately, the Huie Constructed Wetlands will have a capacity of over 15 MGD.	• The project was required to meet Georgia's surface water and groundwater quality standards • A NPDES Stormwater Construction Permit was required because the project disturbed more than 5 acres	• As part of the project, Clayton County Water Authority built a wildlife preserve and education building.	• The greatest challenge facing the project was converting portions of the land application system to wetlands in a phased manner while continuing to operate the land application system.	• Clayton County Water Authority estimates that treating wastewater in a constructed wetland is $4.73 per 1,000 gallons compared to $10 per 1,000 gallons in a mechanically complex facility that discharges directly into a body of water • Some project funding will be provided by the Clean Water State (Georgia) Revolving Fund as loans	The project is proceeding as planned in a phased approach.	• The Clayton County project demonstrates the viability of treating WWTP effluent in a constructed wetland system to provide indirect augmentation of a raw water supply. • The project is an example of a successful public education program that allowed the project to enjoy high public acceptance.

(This page intentionally left blank.)

6.2.1 El Paso, Texas

El Paso Water Utilities (EPWU) operates an extensive recycled water system. Most recycled water is used for industrial purposes and landscape irrigation. The program is organized geographically and strives to minimize the amount of water pumped from aquifers and supplement treatable flows from the Rio Grande. EPWU operates four recycled water projects:

- Northwest Reclaimed Water Project – includes the Hueco Bolson Recharge Project
- Northeast Reclaimed Water Project
- Southeast Reclaimed Water Project
- Central Reclaimed Water Project located at the Haskell R. Street Wastewater Reclamation Plant

One important component of this system is the Hueco Bolson Recharge project wherein wastewater is treated to potable water standards and injected directly into the aquifer that is a major drinking water supply for the City of El Paso. The Fred Hervey Wastewater Reclamation Plant (FHWWRP) that treats water for the aquifer recharge uses an advanced treatment process in two parallel, 5-MGD trains (10-MGD total capacity). Approximately 4 MGD of the recycled water is used for indirect potable reuse. The treatment processes for the Hueco Bolson Recharge project include:

- Primary treatment (screening, degritting and primary clarification)
- Equalization
- Powdered activated carbon (PAC) combined with conventional aerated biological treatment
- Lime treatment
- Recarbonation
- Sand filtration
- Disinfection (high-pH lime followed by ozone)
- Granular activated carbon (GAC) filtration
- Multiple clearwells with batch testing

When the Northeast Recharge Project was completed in 1985, regulatory requirements for recycled water recharge of an aquifer used as a primary drinking water supply were not defined. The National Interim Primary Drinking Water Regulations and the TCEQ (formerly Texas Natural Resource Conservation Commission or TNRCC) Drinking Water Standards were used as quality guidelines for the FHWWRP discharge permit. In addition, the regulatory requirements for the Water Factory 21 project in Orange County, California, were also considered.

The FHWWRP is required by the TCEQ to continuously monitor very specific water quality parameters described in its discharge permit. Samples of the product water are taken as each clearwell is filled. These samples are analyzed for indicator organisms. If the product water does not meet total coliform criteria, it is reprocessed through the treatment train.

The recycled water projects were funded by grants from the Texas Water Development Board and the U.S. Bureau of Reclamation, U.S. Economic Development Board, and revenue bonds issued by the City of El Paso.

Due to severe needs for water resources, the cost of developing alternative resources, and a positive public education program, the El Paso recycled water projects received positive public acceptance and are currently thriving. Expansions are under construction and more are planned.

With regard to the DWU recycled water implementation plan, the following insights may be gained:

- Funding from state and federal entities may be available.
- Public understanding breeds cooperation and acceptance.
- The use of recycled water for recharge is a viable means of augmenting an existing water supply.

6.2.2 Odessa, Texas

Odessa, Texas, has been using recycled water for over fifty years. The South Dixie WWTP, built in 1949, included a recycled water component. With the transfer of all municipal wastewater treatment to the Bob Derrington Plant, the recycled programs continued. Recently, the program has expanded beyond supplying water to industries and golf courses to include a dual irrigation system in a new housing development.

Odessa has designed and constructed wastewater treatment facilities and recycled water distribution systems with recycled water and customer needs in mind. Odessa continues to develop its customer base. Odessa is in the enviable position of having more customer demand for its recycled water than it has water available.

One of the main issues facing Odessa at this time is the structuring of recycled water contracts when all of the water is obligated. The supply contracts specify that the City does not guarantee delivery of recycled water on any day at any time (interruptible service). The customer is responsible for an alternate water supply, storage, and all costs for provision of water. The challenge has become how to apportion recycled water as a scarce and vital water resource.

The Odessa program is operating, maturing, and growing. Scarce water resources and a long, successful history of water reuse has led to public acceptance of the various recycled water projects, including the dual water systems in new development areas.

Odessa's experience has shown that when water resources become tight, recycled water will become a valuable and indispensable resource. "The good news is that wastewater is being transformed into a high quality water resource. The bad news is that there's not enough to go around."

6.2.3 Tarrant Regional Water District

The Tarrant Regional Water District (TRWD) is developing a constructed wetland system to process Trinity River water (predominantly treatment plant effluent during the summer months) and recycle this water to the Richland-Chambers Reservoir to augment surface water resources. The reservoir supplies raw water to Dallas-Fort Worth area utilities. The objective of the wetland is to remove nutrients and other contaminants from the water before it is introduced into surface water supply reservoirs. The District's project has progressed from pilot to field-scale operation.

Initially, a 70,000-gpd, pilot-scale constructed wetland was designed and constructed and has now been operating since early 1993. The field-scale project, started up in April 2003, covers about 220 acres, and can treat about 12 MGD of water diverted from the Trinity River. This field-scale project is the first phase of a full-scale constructed wetland project for Richland-Chambers Reservoir that will supplement the yield of the reservoir by up to 150 MGD. The design includes facilities required for proper operation and maintenance of the constructed wetland. The next phase of the project includes the expansion of this facility to about 1600 acres, treating about 68 MGD.

The District has conducted extensive monitoring, sampling, and data analysis to determine flow balances and mass balances for carbon, nitrogen, phosphorus, solids, and other constituents. Special research was also performed to evaluate the establishment of vegetative cover using the seed bank in wetland topsoil versus planting of selected plant species.

Several issues were and continue to be assessed, including the long-term ability for phosphorus and nitrogen removal and retention within a constructed wetland, the performance of various plant species selected from the native wetland areas in the region, operational requirements for effective removal of nutrients and potential contaminants, and overall water quality improvement through the use of a constructed wetland. The effluent quality from the wetland system has been shown to be of high enough quality to be discharged into the reservoir.

The field-scale constructed wetland will be operated and monitored for the next several years. Recycled water product from the wetland is currently being returned to the Trinity River. Water rights issues must be resolved before the wetland treated water can be discharged into Richland-Chambers Reservoir and the wetland system be expanded to full capacity.

The pilot-scale and field-scale projects have demonstrated the ability of a constructed wetland system to process effluent-dominated stream flows to a quality suitable for augmentation of a primary raw water supply (indirect potable water reuse). The positive response of the public and their involvement in the educational aspects of this award-winning project have helped open the door to opportunities for reuse in the Dallas-Fort Worth area.

6.2.4 Scottsdale, Arizona

Scottsdale has two water reclamation plants. The conventional treatment plant treats water to a quality acceptable for landscape irrigation. An advanced treatment plant called The Water Campus treats water to a quality acceptable for direct aquifer recharge. The Scottsdale projects went online in the early 1990s.

Project Description

The Water Campus consists of two plants—a Water Reclamation Plant (WRP) and an Advanced Water Treatment (AWT) facility. The WRP has a capacity to treat 12 MGD (currently being expanded to 16 MGD, with an ultimate capacity of 19 MGD) of wastewater to acceptable irrigation-quality recycled water, and consists of primary and secondary sedimentation basins, aeration basins, filtration basins, and the associated pumps, electrical and instrumentation.

The AWT facility treats raw Colorado River water with microfiltration (MF) treatment, and further treats WRP effluent with disinfection, microfiltration (MF), and reverse osmosis (RO) processes prior to injection as recharge into the local aquifer. The AWT has a capacity of 12 MGD and is currently being expanded to 16 MGD.

Water injected into the aquifer remains approximately two to three years before it is pumped out again.

The City of Scottsdale's Water Campus enables the City to comply with stringent state water regulations while also addressing rapid growth. Completed in 1999, the Water Campus is one of the largest water reclamation facilities in the country treating wastewater to a quality above that required for indirect potable reuse. The project's objectives were to:

- Reclaim and reuse the City's wastewater.
- Eliminate the need to purchase additional capacity at a regional wastewater treatment plant.
- Allow for the area's continued growth and development.
- Maintain compatibility with a beautiful desert setting.
- Meet requirements of Arizona's Groundwater Management Act.

The City of Scottsdale and a number of other stakeholders worked together to assure project success. The Water Campus's objectives were met within a framework of (1) environmental protection, (2) client satisfaction, (3) originality and innovation, (4) complexity, and (5) contributions to social and economic advancement.

The Water Campus has made several contributions to social/economic advancement of the region. Groundwater has been the major source of water supply in Arizona and, historically, it has been pumped out faster than it is replenished. The Water Campus is an outstanding example of the use of technology to protect and enhance this precious resource. By providing irrigation water to keep the City's golf courses green, the Water Campus boosts tourism, the mainstay of the local economy.

Issues and Challenges

Public Acceptance

Throughout the project, from the conceptual phase through construction, public meetings were held to gather public input and concerns. A quarterly newsletter was mailed to all city residents. When the Campus was dedicated, the City held a three-day Open House that included guided tours of facilities, displays, and other information. More than 600 citizens toured the facility.

The Frank Lloyd Wright Foundation's Taliesin West House designed the Water Campus buildings, and the grounds were purposely designed to be aesthetically pleasing and blend well with the desert environment.

Property values in the area have increased and for these and other reasons the public has shown great support for the Water Campus. Local news reports have shown how cutting-edge technologies are helping to keep the city green; and community residents, school groups, and visiting scientists and engineers tour the Campus regularly.

Regulatory Compliance and Permitting

The Water Campus is a key contributor to Scottsdale's compliance with Arizona's 1980 Groundwater Management Act and assurance of a 100-Year Adequate and Assured Water Supply required by the Arizona Department of Water Resources.

Another benefit of the Water Campus is that it allows Scottsdale to require new golf courses to give their water rights to the City. The City, in turn, sells the golf courses recycled water for irrigation and expands its own water rights.

Technical Issues

The Water Campus is the first permitted facility in Arizona and currently one of the largest in the nation to treat wastewater to drinking water standards using MF and RO technologies. MF had never before been applied to the pretreatment of wastewater prior to RO. The project is also the first large facility anywhere to use thin-film-composite RO membranes, which provide a much higher rejection of dissolved material at only half of the operating pressure – thus saving energy. An extensive piloting program verified the effectiveness of the MF and RO technologies in a full-scale application. The WRP effectively treats a large volume of wastewater (12 MGD with an ultimate capacity of 19 MGD) to a level acceptable for irrigation and/or subsequent treatment at the AWT facility. The AWT facility acts as a dual-purpose facility through both the MF treatment of raw Colorado River water for injection into the aquifer and by treating WRP effluent with both MF and RO for injection as well.

Financial

The City spends approximately $1 to treat 1000 gallons of recycled water. This cost does not include capital or membrane replacement costs.

Project Status

The Water Campus has been in continuous operation since the mid-1990s. The WRP expansion to 16 MGD should be complete in mid-2006. The AWT facility expansion to 16 MGD should also be complete in mid-2006.

Insights for DWU Recycled Water Program

The Scottsdale Water Campus has demonstrated that use of recycled water for recharge of a drinking water aquifer (indirect potable water reuse) is a viable means of augmenting an existing water supply.

6.2.5 San Diego, California

The City of San Diego imports virtually all of its water from other parts of the state, and current supplies are projected to be insufficient to meet future demands. Thus, San Diego investigated indirect potable recycled water as one measure to help alleviate water shortages in the future.

The City operated three different pilot projects to develop information on the effectiveness and reliability of a recycled water treatment train and to examine the effects of highly treated recycled water on human health. The project did not progress beyond the pilot-scale work due to public concerns. The pilot-scale work ceased in 1998.

The goals of San Diego's total resource recovery project were to:

- Demonstrate the effectiveness of a recycled water treatment process train.
- Examine the health effects of using highly treated recycled water as a raw water source.
- Examine the reliability of the treatment process train.
- Construct and operate a full-scale recycled water treatment plant.

Project Description

The San Diego Total Resource Recovery Project consisted of a series of three research projects, each building on the knowledge of its predecessor: Aqua I (bench-scale), Aqua II (pilot plant) and Aqua III (full-scale demonstration plant). Aqua I was a reverse osmosis pilot plant for research and to provide irrigation water. Aqua II was a 0.3-MGD pilot plant to test the concept of treating wastewater through an aquatic treatment pond system and an advanced wastewater treatment plant. Aqua III consisted of water hyacinth secondary and tertiary processes designed to treat 1.2 MGD and a packaged advanced water treatment system with a capacity of 0.5 MGD. The blended effluent is used for irrigation.

San Diego's Water Repurification Project was planned to be a practical full-scale (30 MGD) advanced wastewater treatment system. Tertiary effluent from the North City Water Reclamation Facility was to be treated in an advanced process train. Recycled water was to be conveyed about 23 miles to San Vicente Reservoir, where it was to be blended with imported water and raw water and treated at the City's Alvarado Water Treatment Plant.

Issues and Challenges

Public Acceptance

Though a public outreach program was implemented, it was not totally effective in this case. The view of the project by some of the public was that effluent from wealthier parts of the city was to be treated and distributed to poorer areas. Some of the local politicians also objected to the project. Opponents of the program dubbed the effort "Toilet to Tap." Public perception, politics, and a catchy slogan erased years of research and careful planning.

Regulatory Compliance and Permitting

The San Diego County Water Authority, as the lead agency, worked with many local, state, and federal agencies to identify design constraints, regulatory requirements, and obtain project approval and permitting.

Technical Issues

Tertiary treatment at the North City Water Reclamation Facility was designed to comply with California's water reclamation criteria and was to consist of chemical coagulation, static mixing, flocculation, high-rate down-flow gravity filtration through anthracite media, and disinfection.

The proposed "repurification" process was influenced by evaluations of San Diego's total resource recovery program and the Denver Potable Reuse Pilot Program. Reverse osmosis (RO) was to be used with microfiltration pretreatment to optimize membrane performance. The recommended primary disinfection process was ozone with supplemental nitrate removal to reduce algae growth in the reservoir.

Financial

Several public agencies helped fund the program and provided guidance. Federal grants through the Federal Water Pollution Control Grant Program were used as partial funding for Aqua II and Aqua III. The remaining funding was provided by the City of San Diego.

Project Status

Collection of health effects data at Aqua III was completed in 1995. The project was ended in 1998 due to public perception and politics. However, the City is currently once again developing a reuse program.

Insights for DWU Recycled Water Program

From a technical perspective, Aqua II demonstrated that rotary disk filters were sufficient primary treatment ahead of the aquatic secondary systems. While land intensive, the hyacinth process provided satisfactory levels of secondary treatment. Furthermore, fouling of the polyamide membrane by organic acids from the hyacinth process could be reduced or eliminated with lime coagulation and sedimentation followed by cellulose acetate membranes. Aqua III was a scale-up of Aqua II and reinforced these findings.

The water quality performance objectives of Aqua II and Aqua III were to show that the process could reliably produce an effluent that can be safely used as raw water supply. For all measured constituents, final effluent concentrations were met and were more favorable than those in the National Drinking Water Standards.

San Diego's technical achievements are important. However, the effort also demonstrated that public perception and political acceptance are critical to success.

6.2.6 Tampa, Florida

The City of Tampa, Florida, has long recognized that the high quality effluent from the Howard F. Curren Advanced Wastewater Treatment Plant is a valuable water resource. They also recognized that additional water supply would likely be necessary to serve the growing water demand. Beginning in 1983, Tampa implemented a pilot-plant project and two conceptual studies to investigate the feasibility of using recycled water to augment their water supply.

Traditional water supply methods available to Tampa include surface water collection and storage and withdrawal of groundwater from well fields. Controlling regulatory agencies have not allowed Tampa to expand its surface water system, and further groundwater development will be limited by regulatory constraints concerning protected wetlands and intrusion of saline water into freshwater aquifers.

The Tampa recycled water program included the design, operation, and testing of a supplementary treatment pilot plant, followed by extensive health effects testing of the effluent water. After a successful pilot project, the project was terminated due to public concerns about the use of recycled water for augmentation of public water supplies and opposition from other water agencies in the area. Tampa has since embarked on projects to desalinate seawater from Tampa Bay to increase its water supply capacity.

Project Description

In late 1985, the design of a 50-gpm supplementary treatment pilot plant was completed. Construction and startup were completed in 1986. This pilot plant was operated from January 1987 to 1989, with toxicological testing continuing through 1992.

<u>Pilot-Plant Project and Health Effects Testing</u>

The pilot plant included preaeration, lime treatment, recarbonation, gravity filtration, and ozone disinfection. Three other processes were evaluated after gravity filtration and before disinfection, including granulate activated carbon (GAC), reverse osmosis (RO), and ultrafiltration (UF). The GAC train outperformed the other processes with respect to removal of organic contaminants. The GAC product water did not exhibit mutagenic activity, and the GAC process had fewer operational/reliability problems than the membrane processes. The GAC process also had a cost advantage compared to RO and UF.

In-depth health effects testing was conducted to evaluate the quality of the ozone-disinfected GAC product water in comparison to the existing raw water supply. The testing indicated that the pilot-plant effluent does not present a significant microbiological or toxicological risk and that the effluent water quality is as good or better than the other sources of raw water, including Hillsborough River water.

Full-Scale Implementation Project

The City of Tampa began working with the Southwest Florida Water Management District and the West Coast Regional Water Supply Authority to implement the Tampa Water Resource Recovery Project. The key items addressed by the Implementation Project were:

- Public Acceptance
- Permitting
- Financial, legal, and administrative issues
- Implementation methods
- Consideration of other water supply options

As previously stated, this project has been terminated due to lack of acceptance, principally by water purveyors in the Tampa Bay area.

Issues and Challenges

Public Acceptance

The chief barrier to public acceptance of indirect potable reuse as a viable water supply was concerns about potential adverse health effects associated with ingestion of recycled water derived from treated wastewater.

Permitting

The State of Florida Department of Environmental Protection (DEP) has regulations addressing indirect potable reuse. The Tampa Water Resource Recovery Project would have met all DEP treatment and quality requirements.

Project Phasing, Funding, and Schedule

The project had secured funding from the USEPA, the Southwest Florida Water Management District, the City of Tampa, and the West Coast Regional Water District for a three-phased implementation plan with incremental plant capacities of 15, 35, and 50 MGD. The schedule for the first phase of the project included 12 months for design, 30 months for construction, and 4 months for startup. Therefore, after the 18 to 24 months allotted for public acceptance, regulatory approval and permitting, it would have taken nearly 4 years before recycled water would be available.

Project Status

The project has been terminated due to lack of acceptance related to health concerns.

Insights for DWU Recycled Water Program

Recycled Water Quality

The production of recycled water that is acceptable as a raw water source is technically feasible with common water treatment technology. Recycled water produced with supplemental, advanced treatment (including GAC, membranes, and ozone disinfection) has not been shown to present a significant microbiological or toxicological risk.

Nontechnical Constraints

Public acceptance, regulatory approval and permitting, legal and administrative issues, and project economics will determine the viability of recycled water projects. Public acceptance is conditional, and sometimes emotional, and requires a significant and politically sensitive education program. In addition, the estimated cost of recycled water was found to be greater than the cost of traditional water supplies. Therefore, unless traditional water supplies fall short of required demand or environmental/regulatory constraints compel the use of nontraditional water supplies, implementation of recycled water projects can face significant obstacles.

6.2.7 Denver, Colorado

The Denver Potable Reuse Demonstration Project was created to evaluate the following issues related to recycled water:

- Recycled water quality
- Public health risk
- Technical and economic feasibility
- Consumer (public) acceptance
- Regulatory acceptance and permitting

The goal of this project was to create a potable water supply that could be delivered directly to the consumer. The recycled water needed to be equal to or exceed the high quality of Denver's existing drinking water supply.

Denver began investigating recycled water as part of a 1968 consent decree with the USEPA that allowed the City to divert water from the Blue River on the west side of the Continental Divide. During the 1970s, the Successive Use Project, consisting of a 5-gpm pilot plant, indicated that potable use of recycled water was a viable alternative.

Project Description

The Denver Potable Reuse Demonstration Project consists of a 1.0-MGD recycled water treatment plant located at the existing Denver Metropolitan Regional Wastewater Facility. The demonstration plant receives secondary-treated, but not nitrified, feed from the regional treatment plant. The advanced treatment at the demonstration plant includes:

- Chemical Treatment (aerated high-pH lime)
- Filtration
- UV Irradiation
- Carbon Adsorption [(granulate activated carbon, (GAC)]
- Reverse Osmosis (RO)
- Air Stripping
- Ozonation
- Chloramination
- Ultrafiltration Sidestream

This multiple-barrier approach was used to produce a highly reliable process in which no one process is entirely responsible for the removal of a given contaminant. Also, with the exception of air stripping, equipment redundancy was incorporated in all of the treatment processes.

Issues and Challenges

Unlike other projects that have the goal of developing a new raw water source or indirectly augmenting an existing raw water supply, the goal of the Denver Potable Reuse Demonstration Project was to create a potable water supply that could be delivered directly to the consumer. Proving the ability and reliability of the treatment technologies to treat the wastewater effluent to meet or exceed drinking water standards without any adverse health effects was the dominant challenge to the project. The City of Denver conducted a pilot study to demonstrate the feasibility of providing potable recycled water directly to the public. After a successful pilot study, the project was terminated due to public concerns about the potential dangers of direct potable reuse.

Project Status

In addition to the multiple-barrier process design approach, the reliability components allowed the demonstration plant to consistently and continuously produce potable drinking water from secondary-treated wastewater. Implementation of a full-scale recycled water project has not been initiated due to public concerns regarding the direct reuse of recycled water for public water supplies. Currently, there are no plans to implement a direct potable reuse project in Denver.

Insights for DWU Recycled Water Program

Denver demonstrated that secondary-treated wastewater could be reliably processed to meet or exceed drinking water standards without any detected adverse health effects.

6.2.8 Clayton County, Georgia

The Clayton County Water Authority (CCWA) is working to ensure that the people of the county will have better quality water in area streams and a long-term, dependable and safe water supply. Increasing water demands of a growing population and an urgent need to meet Georgia's surface water and groundwater quality standards prompted CCWA to seek creative solutions. CCWA created a master plan and a water resource management program considered one of the best in the country.

With advanced treatment and disinfection, followed by a combination of constructed wetlands and forested land application, the CCWA reclaims treated wastewater to augment raw water sources. CCWA is also enhancing the county's water resources further by creating plans for restoring local streams that have been degraded by development.

Project Description

The CCWA is expanding and replacing some of its existing wastewater treatment land application facilities with constructed wetlands for the purpose of wastewater treatment. CCWA's wastewater treatment facilities are reaching their design capacity and need to be expanded to handle increased growth and flows. Treatment wetlands are a preferred alternative as they can provide more capacity per acre as compared to land application. Wastewater will be treated to advanced secondary standards then pumped to the wetland cells for additional treatment before discharge into one of CCWA's secondary water reservoirs for reuse.

The existing Huie Land Management site historically used a land application system (LAS) to further treat effluent from two WWTPs. A portion of the LAS was converted to a constructed wetland system in a four-phased program. Ultimately, the Huie Constructed Wetland will have a capacity of over 15 MGD. A second wetland project is being created that should bring the total daily capacity to 34.5 MGD.

CCWA also built a wildlife preserve and education building (the Newman Wetlands Center) to mitigate the habitat loss that came from construction of the Shoal Creek Reservoir.

Issues and Challenges

Public Acceptance

As part of this project, CCWA built a wildlife preserve and education building (the Newman Wetlands Center) to promote public education and acceptance of the project. The Newman Center hosts a wetlands and watershed festival, environmental exhibits, guided walks through nature trails, etc.

Regulatory Compliance and Permitting

CCWA was required to meet Georgia's surface water and groundwater quality standards. Their historical use of a land application system (LAS) to dispose of WWTP effluent could not meet these requirements, especially with growing population and effluent quantity. The conversion of the LAS to a constructed wetland required Section 404 permitting. Directional boring and other techniques were used to minimize the conversion effort. Also, because more than five acres were disturbed, a NPDES Stormwater Construction Permit was required.

Technical Issues

The greatest challenge facing this project was converting portions of the LAS to wetlands in a phased manner while continuing to operate the LAS.

Financial

The CCWA claims that the cost of treating wastewater in a wetland is $4.73 per 1000 gallons compared to $10 per 1000 gallons in a “mechanically complex” facility that discharges directly into a body of water.

CCWA has obtained some of the funding (loans) for this project from the Clean Water State (Georgia) Revolving Fund.

Project Status

The project is proceeding as planned in a phased approach.

Insights for DWU Recycled Water Program

The Clayton County project demonstrates the viability of treating WWTP effluent in a constructed wetland system to provide indirect augmentation of a raw water supply. After mixing with natural water in the raw water supply reservoir, the water receives further treatment at a conventional water treatment plant. It also provides an example for a successful public education program that allowed the project to enjoy high public acceptance.

6.3 Summary of Insights Relevant for the DWU Recycled Water Program

The experience gained by other recycled water programs can provide insight into the opportunities and challenges facing DWU. The following are some insights that should be considered:

- Traditional water supply methods including surface water collection and storage and withdrawal of groundwater from well fields are often limited. Regulation and environmental concerns often limit the ability to expand these resources. Water suppliers are therefore evaluating nontraditional water supply options, such as aquifer storage and recovery (ASR) and the use of recycled water (highly treated wastewater effluent) to augment their water supplies.

- Planned indirect potable and nonpotable reuse will likely play a larger role in the integrated water resources mix of more communities. Different communities will likely use a wide array of approaches, including:

    - Nonpotable reuse practices
    - Dual water systems

- Groundwater recharge and augmentation of surface impoundments
- Small-scale onsite water recycling facilities

- The technology required to implement a recycled water program is common to the water treatment industry. Typically, the wastewater treatment required is no more stringent than the standards already being met by DWU's wastewater treatment plants (WWTPs). Planned augmentation of potable supplies via indirect potable reuse, however, requires a substantially higher level of treatment. Advanced wastewater treatment processes and a high level of disinfection are needed to assure health protection for consumers of the water. In addition, limits on the percent of augmentation, retention time in natural systems, and advanced water treatment technologies can provide additional barriers.

Research studies, demonstration projects, and information obtained from existing indirect potable reuse projects have indicated that recycled water can be used for indirect potable use without presenting measurable health risks. The effluent water quality is as good or better than other sources of raw water.

- Public acceptance of recycled water projects will be critical to their success. Typically, recycled water used for irrigation and industrial/commercial process water is readily accepted by the public, while recycling water to augment potable water supplies, either directly or indirectly, is often viewed with concern. The chief barrier to public acceptance of indirect potable reuse as a viable water supply is concerns about potential adverse health effects associated with ingestion of recycled water derived from treated wastewater. An extensive public information and involvement campaign is a key element to any successful implementation plan.

The greatest challenge facing implementation of a recycled water program is identifying economically feasible opportunities for application of established recycling technologies. Recycled water can be a valuable and marketable commodity, and as such, pricing and promotion are critical to market development. In many cases, the cost of recycled water was found to be greater than the cost of traditional water supplies. The greatest opportunity for justifying a recycled water project will be based on the savings associated with deferring anticipated large water supply capital improvement projects and/or providing a water source where other options are not available.

CHAPTER 7

PUBLIC PERCEPTIONS OF RECYCLED WATER PROGRAMS

7.1 Public Perceptions of Recycled Water Programs

This chapter presents, based on published case studies, water reuse programs that implement and maintain a public outreach program. Typically these programs do not experience the time delays and financial setbacks that seem to be common for projects that ignore or do not maintain the outreach programs. This chapter begins with a discussion of examples of public outreach programs and their roles in reclaimed water projects. The role that a public outreach program plays in the success or failure of a water reclamation project is also addressed. The second part of this chapter provides a summary of the public meetings held in conjunction with this project and briefly outlines an approach to working with the public to implement the reclaimed water implementation plan.

7.2 Projects that Benefited from a Public Outreach Program

The following water reuse projects benefited from a public outreach program. While the components of the public outreach programs varied from project to project, it is apparent that early implementation of a public outreach program typically resulted in timely public acceptance.

El Paso Water Utilities, Texas

The City of El Paso is situated in the middle of the desert in West Texas. Since its water resources are limited to aquifers and the Rio Grande River, El Paso Water Utilities (EPWU) made the decision in 1963 to begin delivering reclaimed water to the community. In doing so, EPWU is able to conserve its valuable potable water for drinking water supplies and utilize the reclaimed water for irrigation or industrial uses. EPWU currently delivers reclaimed water to the El Paso Electric Company, Painted Dunes Golf Course, Ascarate Golf Course, the Bowen Ranch, and residential customers for irrigation.

EPWU has successfully completed multiple water reuse projects including the NW Wastewater Reclamation Facilities project, Haskell R. Street Reclaimed Water project, and the Bustamante Wastewater Plant to the Riverside International Industrial Center project. Because EPWU already had a strong water conservation program in place prior to initiating these reuse projects, public response was favorable when reuse projects were proposed.

The EPWU water conservation program includes brochures and pamphlets, online resources, financial incentives in the form of lower water rates for reclaimed water users, workshops, and direct access for the public to EPWU senior staff to ask questions or discuss concerns. In addition, the EPWU maintains a good relationship with the media by continually updating and educating them on new water reuse developments. As a result, media coverage and public response to proposed water reuse projects has been favorable.

Irvine Ranch Water District, California

The Irvine Ranch Water District (IRWD) was formed in 1961 to provide water and irrigation to a rapidly growing community. Since much of the IRWD drinking water was purchased from unreliable, outside sources, it incorporated other water supplies including a local water well field. Two years after its inception, the IRWD made the decision to begin collecting and treating wastewater as well as producing reclaimed water. By 1967, this reclaimed water was being supplied to agricultural users to irrigate crops. As part of its aggressive water conservation program, the IRWD has since broadened its use of reclaimed water. Reclaimed water is now used on crops, golf courses, parks, school grounds, greenbelts, street medians, and freeway landscaping. Furthermore, it is supplied to local high-rise office buildings and individual homeowners for flushing toilets and is scheduled to be supplied to office towers and other buildings for similar use.

These highly successful, innovative projects have placed this community among the nation's water reuse leaders. Much of this success is a result of an aggressive public outreach program that is part of the IRWD's water conservation program. This outreach program includes: 1) a residential tour program, 2) an in-school education program, and 3) newsletters and brochures.

The residential tour program is free and provides area residents an opportunity to learn more about the district facilities and water supply issues. A member of IRWD's board of directors as well as the senior staff begin the tour with a presentation and question and answer session on the district's history, water sources, conservation information, and other similar topics. Participants are supplied with packets that include district information and free conservation devices like low-flow shower heads and faucet aerators. Following this presentation, participants are taken on walking and driving tours of the Michelson Water Reclamation Plant (MWRP) and IRWD points of interest (i.e., reservoirs, reuse sites, wells, etc). The tour is concluded with a lunch at the Duck Club, an historic building adjacent to the MWRP during which additional water conservation techniques are discussed and a survey rating the tour's educational effectiveness is provided. Based on the positive responses documented by this survey, the residential tour program has been an effective method to educate the public on water conservation and water reuse.

An in-school education program was created to educate students on the importance of water to Southern California's arid region. It was developed not only to correlate with, but also supplement, the school district's social science curriculum by offering free classroom presentations, videos, workbooks, tours, and special projects. Students are taught a variety of topics including water pollution prevention, water conservation, and point versus nonpoint source pollution. Teachers receive "leave behind" materials (i.e., booklets, posters, and stickers) as well as an evaluation sheet, the results of which assist the IRWD in refining the program so it will maintain pace with current academic trends. Many students also participate in the IRWD's residential tour program each year. IRWD staff members are also involved in the program by not only serving as guest speakers in the students' classrooms but also as science fair judges. The winning students get their projects displayed at district headquarters, are recognized at a board of directors meeting, and a financial award is given to the student's school district for the purchase of science materials.

In order to keep teachers abreast of new programs, presentations, and materials, the IRWD publishes newsletters and brochures twice annually. These materials provide educational program highlights, announcements of student award winners, and other information such as how to book a speaking engagement. Finally, the IRWD provides teachers educational mini-grants each year that supplement school budgets and allow teachers to provide water or other environmental education programs that might not otherwise be possible.

Orange County, California

The Irvine Company, located in Monterrey, Orange County, California, has been irrigating produce with reclaimed water for over 20 years; however, this method was not advertised to the public. In order to determine if there was a need or desire to label the produce to indicate the source of irrigation, a series of interviews was conducted with brokers, receivers, and wholesale and non-wholesale buyers.

The results of these interviews indicated that labeling was not recommended unless it would add some value to the product. Nevertheless, the growers remained concerned about how the public would perceive the source of the irrigation water. Therefore, three approaches were developed to help control public perception: 1) operate the treatment plant beyond regulatory requirements, 2) conduct an education program, and 3) plan for real or perceived problems.

The public education program included an active school education component with multiple classroom demonstrations. Booths were set up at county fairs and other local events and speakers were available to civic or service groups. Furthermore, tours of the water reclamation plant were conducted and education materials were included as part of bi-monthly billing materials. Finally, a crisis communication manual was prepared to deal with possible scenarios and educate growers on how to deal with the press. While growers remain concerned about the possibility of negative public perception, they are confident they have the tools in place to deal with it if needed.

Phoenix, Arizona

The 91st Avenue Wastewater Treatment Plant (WWTP) located near Phoenix, Arizona, utilizes reclaimed water for agricultural irrigation and industrial purposes. The reclaimed water supply is the greatest during the winter months due to the influx of winter visitors, while the supply is lowest during the summer months as a result of higher demand. Because this WWTP is located in a desert environment where water is such a valuable resource, the Subregional Operating Group (SROG), which owns the WWTP, began researching methods to capture the unused portions of reclaimed water present during the winter months.

Groundwater recharge was proposed as an efficient method to store the excess supply for later recovery during periods of higher demands. This proposal became known as the Agua Fria Linear Recharge Project (Agua Fria Project). This project specifically involved transporting reclaimed water from either the 91st Avenue WWTP or a series of constructed wetlands into the Agua Fria River. The reclaimed water would supplement the renewable water supply, improve the habitat along the river, and provide recreational and educational opportunities to the community.

Stakeholder coordination and public information was the first phase of a four-phased plan that was developed to create stakeholder consensus, address technical issues, and secure all necessary permits. During this first phase, stakeholders were identified along with issues of concern. Meetings were then conducted with several stakeholder groups while others were interviewed via telephone. A project newsletter was distributed to the public within a one-mile radius of the proposed project, and then two public meetings were conducted to gather public input. The input was compiled and organized into common themes and several technical committees were assigned to address these concerns.

This public involvement program proved to be very successful. The efforts conducted as part of this program led to the creation of one document that addressed the public's concerns and provided recommendations and guidelines that will be invaluable as the next phase of the Agua Fria Project begins.

Pinellas County, Florida

Pinellas County Utilities (PCU) recognized a public educational opportunity after it renovated its South Cross Bayou Water Reclamation Facility. To help students and residents better understand water reclamation, the importance of clean water, how people can help manage their limited water resources, and the various careers in water and wastewater treatment, the PCU created a hands-on educational program.

This program included supplemental educational materials for teachers to use in the classroom. It also included a hands-on tour of the South Cross Bayou site in which tour participants are able to conduct their own water quality testing and compare it to results reported from a professional laboratory. Finally, video presentations before and after the tour highlight various aspects of the water reclamation process.

Scottsdale, Arizona

Scottsdale, Arizona proposed and successfully implemented a water reclamation project known as the "Water Campus." The "Water Campus" is a water reclamation plant that discharges approximately 20 million gallons of reclaimed water per day. This water is then utilized as irrigation water at several local golf courses. In an effort to conserve the water during periods of low demand, it is treated to drinking water standards, and then fed back into the aquifer. Due to the potential for negative public perception of recharging the aquifer with reclaimed water, the City implemented a three-step process.

First, a technical advisory committee was formed at the onset of the proposed project that included local professors and other members of the community. Efforts were made to educate these members about the importance of reclaimed water and how it related to the proposed project. Once educated, the members of the technical committee became strong allies for the project. Second, several neighborhood meetings were held to educate the community as well as give them a chance to ask questions about the proposed project. Finally, an open house was conducted at the plant with invitations to local residents as well as the media. The open house was heavily attended and many residents left with positive views of the proposed project.

Furthermore, these positive views were then broadcast to the community at large during interviews with the local media. The cumulative results of these efforts worked to educate the community and create a positive perception of the proposed project.

St. Petersburg, Florida

St. Petersburg, Florida, began supplying reclaimed water to be used for residential irrigation in 1977. Nearly 20 years later, the popularity of the program had increased, so the program was expanded to include additional customers. Incentives such as lower water rates were offered and neighborhood participation rates were lowered to encourage additional hookups.

In addition to these incentives, the City conducted a public outreach program. The public outreach program consisted of speaking engagements, educational materials such as books, CD-ROMs, and videos permanently on display at the local library, and the creation of two Xeriscape demonstration sites. Furthermore, the City has sponsored various educational programs, contests, and forums to educate the public on how to conserve and protect the valuable water resources.

Yelm, Washington

In 2001, the City of Yelm, Washington, began producing reclaimed water. This water is used for irrigation at schools and churches, for automobile wash water, and supply for fire hydrants. The reclaimed water is produced at the City's award-winning water reclamation facility that is composed of an eight-acre memorial park, a fishing pond, and a constructed wetlands system. These facilities have been very popular to the public who frequent the facility to fish, view wildlife, and even hold weddings.

The City has an active program to promote its reclaimed water use. As a part of this program, the City sponsored a contest to see which student could create the most imaginative water reuse mascot. This contest was taken a step further by local teachers who created a skit with the winning mascot ("Mike the Pipe") along with other characters ("Water Sprite," "Little Bug," and "Sledge") to teach what the different options are with water that is disposed down a drain.

7.3 Projects that Suffered Due to Poor Public Outreach

The following are examples of water reuse projects that were negatively impacted due to a poor public outreach program. In both cases, the proposed project was technically sound; however, project delays were realized due to either the lack of or failure to maintain a strong public outreach program.

Cape Coral, Florida

The City of Cape Coral, Florida is a rapidly growing community with a fluctuating winter population. Due to water supply concerns, along with the need to dispose of wastewater effluent, the City developed the Water Independence in Cape Coral (WICC) project. This project involved the installation of a dual water system that would deliver potable and reclaimed water in parallel pipelines to the community. The project was created without any public outreach activities. Consequently, when the public did become aware of the project, their negative reaction resulted in delaying the project for six and a half years. Had a public outreach program been formed early in the planning stage, it could have addressed the public's concerns prior to finalizing the program.

The project was a major success once it was finally constructed, by conserving more than four billion gallons of potable water in the project's first eight years. Soon, however, residents began excessive use of the reclaimed water, and it became necessary to apply restrictions on reclaimed water use. Having learned its lesson, the City implemented a new education campaign to encourage responsible reclaimed water use. "Cape Coral Alligator" was created to remind users of proper watering times and other water conservation practices. Furthermore, a hotline was also formed that residents could call to confirm watering schedules. As a result of the now successful reclaimed water programs, the City is prepared to be able to supply water for its anticipated future growth.

City of San Diego, California

The City of San Diego has very limited local water supply sources; therefore, it is forced to import the majority of its water supply from outside sources. In an effort to supplement the limited local water supplies, the City proposed the "Water Repurification Project" in which treated reclaimed water would be piped into and blended with surface water reservoirs thus increasing the available water supply.

Due to the nature of the proposed project, the City of San Diego recognized that public acceptance was critical to the project's success. Consequently, the City initiated public involvement efforts as soon as technical studies began. Telephone surveys, focus groups, and stakeholder interviews were conducted to identify local supporters for the use of repurified water, and other education efforts were targeted towards the local media. City and San Diego Water Authority (the Authority) staff conducted a community outreach program using print and visual materials. Tours of the pilot plant were provided and policymakers and their staffs were briefed on the proposed project. While these initial efforts resulted in early public approval, numerous factors emerged as the project progressed that changed the public perception.

Shortly after moving from the concept to the design phase, the City changed the project team from the Water Repurification project team to the Wastewater Department. This change may have sent a mixed message to the public and caused them to view the project as a wastewater disposal rather than as a water supply solution. As the project neared final approval, key election dates were ignored and final approval of the project by the City Council was scheduled concurrently with several competitive elections. Consequently, final approval was delayed until after these competitive elections. Misinformation generated by various political candidates running for office was not promptly addressed by members of the proposed project and resulted in the misinformation being perceived as the truth. Early education efforts and relationships with the media were not maintained and resulted in negative media coverage. Finally, early efforts to identify all interested stakeholders overlooked a group of residents that lived outside the City's jurisdiction. As a result, these residents, who had not received any mailings with accurate information, began to aggressively oppose the project at various public meetings. As a result of the collapse of the public information program and failure to include several key stakeholders, the San Diego project was defeated and delayed several years.

7.4 DWU Recycled Water Implementation Plan Public Meetings

The DWU has conducted three public meetings related to the Recycled Water Implementation Plan and made two presentations to the City Council. The first public meeting was conducted as part of the series of public meetings associated with the DWU Long Range Water Supply Plan (LRWSP). The last two public meetings specifically focused on the Recycled Water Implementation Plan and were not scheduled in conjunction with the LRWSP public meetings. In addition to these three public meetings, recommendations from the Recycled Water Implementation Plan were included in other presentations made at public meetings associated with the LRWSP. The public is invited to all City Council meetings. A brief description of the topics discussed at each of these meetings and the public response is presented below.

City Council Briefing – August 4, 2004

- Presentation of Recycled Water Implementation Plan project status to City Council.
- Provided summary of preliminary recommendations.

Briefing to City Council Special Joint Committees of Health, Environment & Human Services and Finance & Audit – February 14, 2005

- Presentation of preliminary recommendations of Recycled Water Implementation Plan.
- Several members of public present; no comments provided by those in attendance.

LRWSP Public Meeting No. 1 – December 13, 2004

- Announcement of meeting provided in local newspapers.
- Presentation included reference to recycled water as potential water supply strategy.
- Public comments towards use of recycled water were positive.

LRWSP Public Meeting No. 2 (Recycled Water Implementation Plan Public Meeting No. 1) – January 26, 2005

- First official public meeting for Recycled Water Implementation Plan
- Announcement of meeting provided in local newspapers.
- Presentation focused primarily on water conservation and recycled water supply strategies.
- Public comments towards recycled water strategies were positive. Several comments suggested that DWU should recycle more water than is recommended in the implementation plan.

LRWSP Public Meeting No. 3 – February 3, 2005

- Announcement of meeting provided in local newspapers.
- Presentation provided supplemental information to the January 26, 2005 meeting and summaries of water supply recommendations (including recycled water) and water treatment recommendations.

- Addressed written comments from January 26, 2005 public meeting. Written comments were all positive towards the recycled water supply strategies and encouraged DWU and the Dallas City Council to increase the use of recycled water in the LRWSP.

LRWSP Public Meeting No. 4 – February 10, 2005

- Announcement of meeting provided in local newspapers.
- Presentation provided updates and summary of water supply recommendations for LRWSP.
- Addressed written comments from February 3, 2005 public meeting. Written comments were all positive towards the recycled water supply strategies and suggested that DWU should list additional recycled water as a potential alternative water supply strategy for years 2040 – 2060 in the LRWSP.

LRWSP Public Meeting No. 5 – February 17, 2005

- Announcement of meeting provided in local newspapers.
- Presentation included review of LRWSP schedule, discussion of public concerns and review of findings and recommendations.
- Only public concern related to recycled water program is question of why DWU cannot recycle more water than is recommended in the implementation plan. Response to this concern was addressed through discussion of economic feasibility, water quality and public health.

Recycled Water Implementation Plan, Public Meeting No. 2 – March 24, 2005

- Announcement of meeting provided in local newspapers.
- Invited 71 people, including representatives from a number of major Dallas businesses, Dallas Chamber of Commerce, US EPA, North Central Texas Council of Governments, Sierra Club and other environmental groups, local school districts, Dallas Irrigation Association, landscaping consultants, religious groups and others.
- No members of public attended and no comments were received.

Recycled Water Implementation Plan, Public Meeting No. 3 – April 12, 2005

- Announcement of meeting provided in local newspapers.
- Invited 139 people, including all those invited to the March 24, 2005 public meeting as well as 68 representatives of wholesale customers of the City of Dallas.
- Those in attendance included representatives from Upper Trinity Regional Water District (UTRWD), City of Denton, City of The Colony, Lakewood Country Club, Texas Committee on Natural Resources and Texas Water Development Board (TWDB).
- Representatives from UTRWD and Lakewood Country Club provided positive comments in support of the Recycled Water Implementation Plan. A representative from the City of Denton encouraged the City of Dallas to keep the City of Denton informed regarding the status and progress of the Recycled Water Implementation Plan, particularly as it relates to augmentation of water supply in Lake Lewisville. The representative from the TWDB reminded the City to provide the recommendations from the Recycled Water Implementation to the Region C Water Planning Group so that they will be incorporated into the updated Region C Water Plan.

7.5 Proposed Public Information Program

Since well-designed public outreach programs have been demonstrated to contribute to the success of recycled water projects, an important component of DWU's implementation plan will be the development of an effective public outreach program. Such a program would identify key stakeholder groups and use a phased approach to informing these groups, soliciting input and gaining trust and support.

Potential components of a public information program include:

- Identification of and partnership with allies
    - ✓ Identification of a "public champion"
- Engagement of stakeholder groups
    - ✓ Identification of target stakeholders
    - ✓ Stakeholder workshops
- Development of a broad-based awareness campaign
    - ✓ Identification of key messages
    - ✓ Production of collateral materials and tools
- Development of media relations program
    - ✓ Media packets
    - ✓ Briefings

Target stakeholders in the initial phases of the recycled water program will likely include industries, park facilities, and golf courses. Future expansion of the recycled water program will most likely depend on generating interest with additional stakeholders for recycled water uses. Public involvement with existing stakeholders and revised outreach materials will need to be developed as appropriate to bring additional stakeholders on board.

Public Information Committee

A well-designed public information program would typically include the formation of a Public Information Committee (PIC) at an appropriate time set by DWU. Based on the analyses of major water users and potential recycled water users developed for this implementation plan, a list of potential membership and/or invited guests for a Public Information Committee (PIC) has been developed. A proposed PIC membership list is presented in Appendix A.

Public Announcements and Responses

To ensure DWU recycled water projects are not misrepresented in the public domain, press releases are suggested as a means of disseminating the project parameters accurately and the goals of the project.

Upon release of project announcement in the press of a recycled water project, the public and City leaders may have questions or be asked questions about the project. City staff and leaders will need to be aware and have been briefed on the project to respond knowledgeably to public inquiries. A "Glossary of Terms" that relate to recycled water projects are also included in Appendix C. An example of "Frequently Asked Questions" about recycled water uses is included in Appendix D.

There are many approaches available for public outreach programs. Ultimately, the most appropriate approach for the Public and Customer Awareness Program will be developed based on the projects being implemented, the City's preferences for interaction with the public, and the identity of the stakeholders.

CHAPTER 8

POTENTIAL RECYCLED WATER CUSTOMERS

8.1 General

In order to determine the viability of a market for the sale of recycled water to individual customers, an analysis of potential customers for recycled water is required. The process utilized to identify specific potential customers was the evaluation of the City of Dallas's water customer database. This evaluation considered average water usage, peak water usage, irrigation customers, water consumption by zip codes, type of usage, etc.

The sale of recycled water to individual customers is one of the primary potential uses of recycled water. Water demand of individual potential recycled customers as determined from the City of Dallas's water customer database is discussed in this section. Average daily usage and peak daily usage, both for domestic water consumption and irrigation metering, were utilized in evaluating the viability of a potential recycled water customer.

The data as provided by DWU did not distinguish between single-family residential, multiple-family residential, commercial/industrial or public customers. A desktop analysis was performed to ascertain the type of customer each water service represented.

8.2 DWU's Largest Potable Water Customers

Dallas Water Utilities provided metering data for the top 100 water customers located within the Dallas service area. These data were in the form of a spreadsheet that contained customer name, address of service, zip code, meter type (domestic or irrigation) and monthly usage for a period from February 2002 through October 2003. The raw data consisted of some 3,244 lines of data, each line representing a water meter, each with 21 months of flow data. The top 100 water customers in the City of Dallas are listed in Table 8-1 and the locations of these water customers are shown in Figure 8-1.

8.2.1 Water Service Characteristics

The data as provided had no designation of the actual type of water usage. The only designation of usage was that the metering data was categorized as either domestic water service or irrigation service. In order to determine which "irrigation" customers are viable potential recycled water customers, a more detailed analysis is needed to verify the actual usage of the "irrigation" service.

An existing water customer with a high volume irrigation service would seem to be an obvious candidate as an initial selection for a potential recycled water customer. However, this may not always be the case. In some cases, an "irrigation" service may not necessarily represent a water usage of landscape watering. For example, Reddy Ice utilizes an average of 134,361 gallon per day through an "irrigation" meter. It is obvious that this usage is for the production of ice and not for the watering of landscaping.

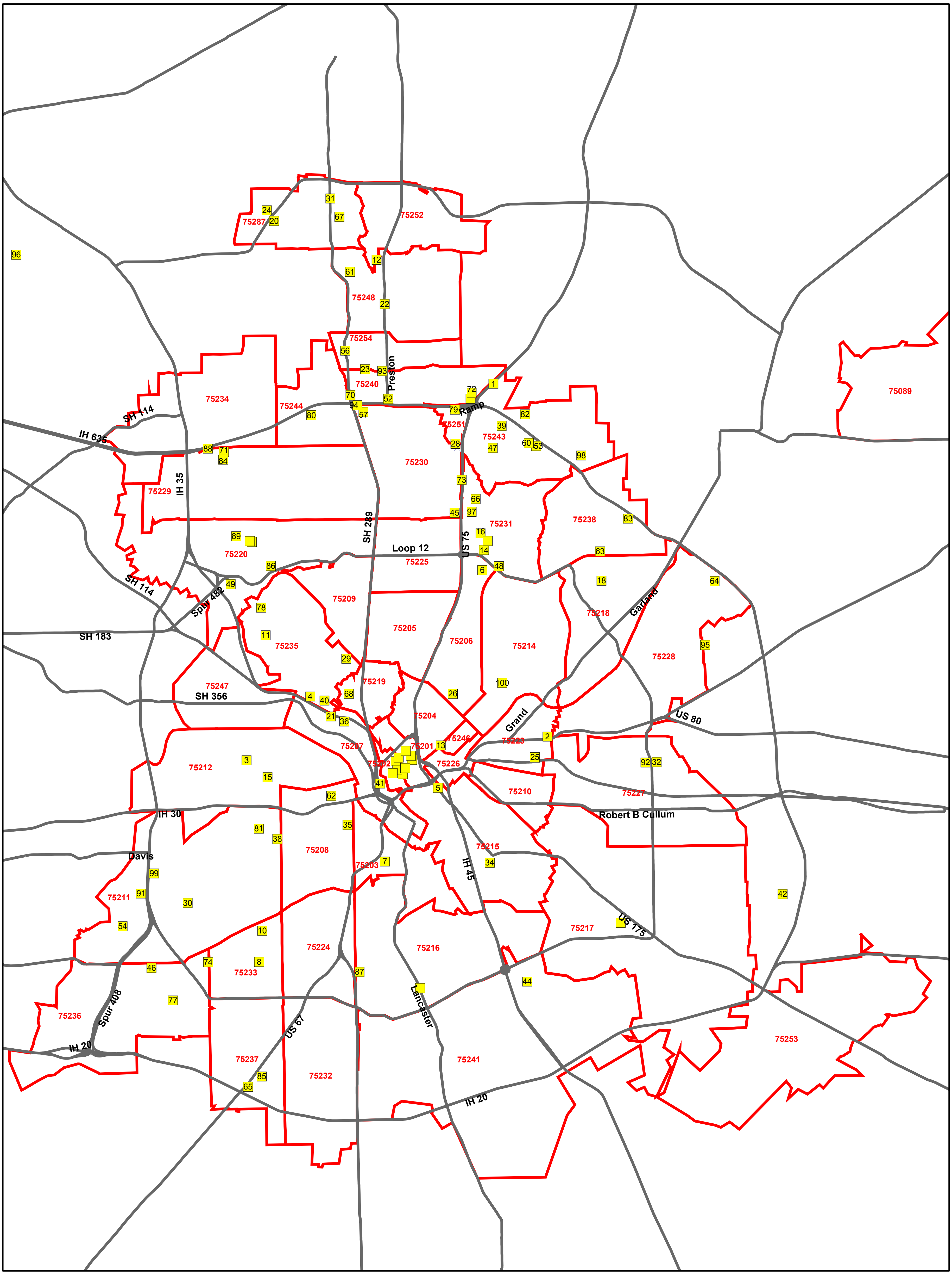
TABLE 8-1
Dallas Water Utilities
Largest 100 Water Customers

	Customer Name	Average (gal/day)	Peak (gal/day)
1	TEXAS INSTRUMENTS	4,841,252	10,031,136
2	CITY OF DALLAS PARKS	1,879,760	9,990,675
3	DALLAS HOUSING AUTH	1,521,272	3,025,171
4	U T SOUTHWESTERN MED CTR	1,445,797	3,291,009
5	PILGRIM'S PRIDE CORP.	1,300,938	1,576,803
6	LINCOLN PROPERTIES	1,270,686	2,900,224
7	ROCK-TENN CO	785,239	1,243,250
8	AMERISOUTH	679,587	1,291,727
9	VETERANS ADMINSTRATION	633,945	1,110,382
10	QUAKER OATS INC	572,368	785,713
11	BROOK HOLLOW GOLF CLUB	290,855	813,580
12	PRESTON TRAILS GOLF	562,617	1,910,532
13	BAYLOR HOSPITAL	474,002	1,371,971
14	FATH HARRY J	443,119	983,653
15	G A F CORPORATION	198,305	298,481
16	THURMAN APTS OF DALLAS	385,980	555,791
17	FANNIE MAE	385,377	799,559
18	WATERVIEW DEVELOPMENT	382,978	4,481,533
19	CRESENT REAL ESTATE	368,191	530,861
20	CAMDEN PROPERTY TRUST	351,143	735,150
21	WYNDHAM ANATOLE HOTEL	347,258	604,511
22	PRESTONWOOD COUNTRY CLUB	190,823	532,626
23	APT OPPORTUNITY FUND II LP	323,792	580,913
24	AMLI	315,163	704,547
25	SCHEPPS-FOREMOST INC	297,928	493,070
26	PERFORMANCE PROPERTIES LLC	288,830	437,697
27	SOUTHWESTERN BELL	288,178	540,968
28	MED CITY DALLAS HOSPITAL	286,244	396,766
29	FIRESTONE JOHN F	282,943	528,702
30	DALLAS NATIONAL GOLF CLUB	271,958	775,930
31	EQUITY RESIDENTIAL PROPERT	272,480	557,635
32	COCA COLA BOTTLING	255,929	333,630
33	ADAM'S MARK HOTEL	243,672	388,458
34	BORDEN INC	242,196	333,087
35	METHODIST HOSPITAL	239,417	423,498
36	DALLAS MARKET CENTER	225,428	564,968
37	DFW AIRPORT BOARD	224,483	356,758
38	WAK MANAGEMENT CO	212,842	389,705
39	OP&F ST ANDREWS PENSION TR	208,868	2,467,128
40	CHILDRENS MED CENTER	208,651	367,539
41	HYATT REGENCY DALLAS	205,091	295,542
42	DALLAS COUNTY MUD NO. 6	203,144	351,321
43	APPLE RESIDENTIAL INCOME	201,529	405,819
44	OCCIDENTAL CHEMICAL CORP	199,556	400,458
45	TVO ARBORS PARTNERS LP	198,161	540,297
46	AMERICANA FOODS	195,290	338,966
47	PRESBYTERIAN VILLAGE	187,066	523,548
48	ALLIANCE FH PORTFOLIO LP	186,355	334,928
49	DALLAS AREA RAPID TRANSIT	186,329	543,256
50	GIDDENS HARVEY	184,462	325,406

TABLE 8-1
Dallas Water Utilities
Largest 100 Water Customers
(continued)

	Customer Name	Average (gal/day)	Peak (gal/day)
51	302 TRAILS LP	182,482	417,109
52	MACERICH VALLEY VIEW LTD	181,397	474,161
53	FOREST SUN CHANCELLOR,LP	179,867	269,260
54	EXTEX LAPORTE	179,116	379,782
55	WILDFLOWER II	175,849	394,215
56	LA/DAV APTS INC	174,214	264,906
57	PRESTON PARK ASSOC	171,741	372,540
58	STEVENS CREEK ASSOC	167,116	251,655
59	FAIRMONT DALLAS HOTEL	166,454	237,252
60	TRACY ISHINO	166,445	283,489
61	BENT TREE COUNTRY CL	164,759	1,479,003
62	NATIONAL LINEN SERV	161,060	202,902
63	TERRACE PARTNERS LP	160,016	283,575
64	HONEYCREEK KIWI, LLC	154,504	282,083
65	TRAMMEL CROW	151,643	334,166
66	AOF/DFW AFFORDABLE HOUSING	151,527	274,932
67	FRANKEL EDWARD B FAMILY TR	148,794	292,324
68	Y & O TERRACE LLC	146,340	314,127
69	TRIZEC PROP INC	142,520	215,878
70	GERALD HINES INTEREST	142,337	232,784
71	ASPENTREE CONS CAP EQUIT	141,200	390,110
72	NOEL PROPERTY MGMT	140,128	270,172
73	BAYPORT FOXMOOR ASSOC	139,562	224,170
74	DALLAS BAPTIST UNIVERSITY	139,046	303,318
75	CROW-EQUITABLE	137,470	193,587
76	CUSHMAN & WAKEFIELD	135,841	249,554
77	REDDY ICE LTD	134,361	284,147
78	SOUTHWEST AIRLINES	133,960	615,120
79	PARK CENTRAL REALTY	133,126	217,410
80	WENTWOOD HARVEST HILL LP	133,022	222,973
81	HARSHAW ASSET CORP	130,836	264,092
82	CANDLEWYCK ASSOCIATES LTD	130,545	235,716
83	DEVONSHIRE REAL ESTATE	130,433	228,171
84	LOFTUS STEVE	129,982	315,123
85	DALLAS CHAUCER I	128,250	266,235
86	ATTILA CONSTRUCTION CO	126,604	286,195
87	W J GROUP I LTD	126,408	202,867
88	ACCOR ECONOMY LODGING	121,569	271,039
89	BROCK APTS PARTNERS LP NCA	118,716	306,035
90	THANKSGIVING TOWER ASSOC	117,735	162,243
91	MOUNTAIN VALLEY 2002,LP	117,453	312,283
92	CEI GROUP DBA	117,325	184,540
93	PRICE PRESTON PARK LP	113,845	236,573
94	DOUBLETREE HOTEL	112,663	177,034
95	DALLAS ATHLETIC CLUB	110,334	328,531
96	EVERGREEN ALLIANCE GOLF LT	106,034	941,721
97	PRESBYTERIAN HOSPITAL	103,678	259,725
98	TRIVEST RIDGETREE LP	102,861	215,628
99	RIDGE CREST LTD	102,418	220,218
100	LAKEWOOD COUNTRY CLUB	93,079	340,432

(This page intentionally left blank)



Legend

Top 100 Water Users

Major Freeways

Zip Code Boundaries

N

0 14,000 Feet

FIGURE	DALLAS WATER UTILITIES
8-1	RECYCLED WATER IMPLEMENTATION PLAN TOP 100 WATER CUSTOMERS

dallas water utilities

apaienv.com

CP&Y

(This page intentionally left blank)

The designation of an "irrigation" meter is done to reduce the wastewater charges to a particular customer. Because it is not cost-effective to meter wastewater use, DWU estimates the customer's wastewater discharge by the average amount of the water billed. The water usage for estimating wastewater charges is the domestic metering, not the irrigation metering. An "irrigation" meter is a meter that does not return flow to the wastewater collection system. As a result, services that are designated in the database as "irrigation" may represent a water service that is used for some other purpose than watering landscape.

Depending on the customer's type of water usage, some water customers with high domestic water usage may be viable candidates for recycled water sale. After the major water customers were identified, a desktop analysis was performed to ascertain the type of customer each water service represented. This evaluation was done utilizing aerial photographs and internet research, and the result is presented in Table 8-2.

8.2.2 Zip Code Analysis

The first procedure was to group the major customers by zip code, which enabled general areas of the City of Dallas to be identified as potential recycled water service areas. The results of this analysis are represented in Table 8-3 and Figure 8-2.

Most of the major water customers have multiple water meters, sometimes located in different parts of the City and often in different zip codes. Whenever this occurred, an analysis was made to group the various metering points of each customer's account into centralized areas, not to exceed one square mile, that may be considered as a single service point for recycled water. DWU had established a selection criterion for considering any water customer for recycled water service of a minimum potential demand of 50,000 gallons per day (gpd). The 50,000-gpd criterion was applied to a potential customer's total consumption of the group of meters within an area and included both domestic service and irrigation service.

When a particular major water customer's service was divided into several differing parts of the City, the daily water usage volume sometimes dropped below the 50,000-gpd criterion. Whenever this occurred, that customer's service or that part of the service that fell below 50,000 gpd was eliminated from the potential recycled water customer list.

Sometimes the division of a major water customer's service into various parts of the City resulted in the customer having more than one point of water service greater than 50,000 gpd. Therefore, the customer was listed as having multiple points for potential recycled water service. The resulting list of service points greater than 50,000 gpd (Table 8-2) contains 141 potential recycled water customers.

The zip code analysis identified 9 zip codes in Dallas in which the total average usage of all major water customers within the zip code was in excess of 1,000,000 gallons per day. These 9 zip codes can be grouped into 5 general areas as presented in Table 8-4.

The analysis provided a limited understanding of Dallas's major water customers. Based solely on this analysis, no definitive conclusions resulting in recommended specific potential recycled customers could be reached.

TABLE 8-2
MAJOR WATER USERS (>50,000 GPD) (All flows in GPD)

	Name	Customer Type	Service Address	Zip	Domestic Water Usage (GPD)		Irrigation Usage (GPD)		Total Water Usage (GPD)	
					Average	Peak Flow	Average	Peak Flow	Average	Peak Flow
1	TEXAS INSTRUMENTS	MANUFACTURING	13592 N CENTRAL	75243	4,804,920	9,957,437	0	0	4,804,920	9,957,437
2	U T SOUTHWESTERN MED CTR	HOSPITAL	5350 MEDICAL CENTER	75235	1,420,855	3,219,145	24,942	71,864	1,445,797	3,291,009
3	PILGRIM'S PRIDE	FOOD PRODUCTION	2411 FERRIS	75226	1,281,290	1,529,714	0	0	1,281,290	1,529,714
4	LINCOLN PROPERTIES	RESIDENTIAL	6608 SHADY BROOK	75206	584,562	992,965	488,550	1,345,745	1,073,112	2,338,710
5	ROCK-TENN CO	MANUFACTURING	1100 E CLARENDON	75203	0	0	784,572	1,241,606	784,572	1,241,606
6	QUAKER OATS INC	FOOD PRODUCTION	2822 GLENFIELD	75233	1,320	3,146	571,048	782,567	572,368	785,713
7	PRESTON TRAILS GOLF	IRRIGATION	17201 PRESTON TRAILS	75248	4,872	17,970	557,745	1,892,562	562,617	1,910,532
8	VETERANS ADMINISTRATION	HOSPITAL	4500 S LANCASTER	75216	536,582	781,272	11,650	61,509	548,232	842,781
9	CITY DLS PARKS - ZOO	SERVICE INDUSTRY	612 E CLARENDON	75203	450,471	919,955	44,521	155,793	494,992	1,075,748
10	BAYLOR HOSPITAL	HOSPITAL	3414 GASTON	75246	473,393	1,370,446	0	0	473,393	1,370,446
11	WATERVIEW DEVELOPMENT	IRRIGATION	10299 WATERVIEW PKWY	75089	0	0	382,978	4,481,533	382,978	4,481,533
12	WYNDHAM ANATOLE DALLAS	HOTEL	2201 N STEMMONS	75207	340,877	585,291	6,381	19,220	347,258	604,511
13	DALLAS HOUSING AUTH	RESIDENTIAL	3200 BICKERS	75212	330,355	878,182	0	0	330,355	878,182
14	SCHEPPS-FOREMOST INC	FOOD PRODUCTION	4935 DOLPHIN	75223	294,541	487,001	3,387	6,069	297,928	493,070
15	BROOK HOLLOW GOLF CLUB	IRRIGATION	8301 HARRY HINES	75235	37,548	63,994	253,307	749,586	290,855	813,580
16	MED CITY DALLAS HOSPITAL	HOSPITAL	7777 FOREST	75230	278,553	372,049	7,691	24,717	286,244	396,766
17	FIRESTONE JOHN F	RESIDENTIAL	3301 HUDNALL	75235	274,887	509,788	8,056	18,914	282,943	528,702
18	DALLAS NATIONAL GOLF CLUB	IRRIGATION	1515 KNOXVILLE	75211	2,121	5,254	269,837	770,676	271,958	775,930
19	DALLAS HOUSING AUTH	RESIDENTIAL	2808 BETHURUM	75215	265,878	366,519	0	0	265,878	366,519
20	ADAM'S MARK HOTEL	HOTEL	428 OLIVE	75201	243,672	388,458	0	0	243,672	388,458
21	BORDEN INC	FOOD PRODUCTION	5327 S LAMAR	75215	242,196	333,087	0	0	242,196	333,087
22	AMLI SOUTHWEST RES.LTD PRT	RESIDENTIAL	3565 TIMBERGLEN	75287	181,910	317,867	58,920	168,370	240,830	486,237
23	THURMAN APTS OF DALLAS	RESIDENTIAL	7040 HOLLY HILL	75231	240,144	332,756	0	0	240,144	332,756
24	COCA COLA BOTTLING	FOOD PRODUCTION	8161 MOBERLY	75227	1,645	3,235	237,902	306,911	239,547	310,146
25	METHODIST HOSPITAL	HOSPITAL	301 W COLORADO	75208	221,947	345,669	11,354	33,528	233,301	379,197
26	DFW AIRPORT BOARD	SERVICE INDUSTRY	2815 AIRFIELD	75261	224,483	356,758	0	0	224,483	356,758
27	FATH HARRY J	RESIDENTIAL	6101 MELODY	75231	208,583	403,818	15,239	47,218	223,822	451,036
28	AMERISOUTH	RESIDENTIAL	2917 W PENTAGON	75233	205,905	356,181	15,347	24,700	221,252	380,881
29	DALLAS MARKET CENTER	SERVICE INDUSTRY	2150 MARKET CENTER	75207	181,724	386,894	34,607	151,592	216,331	538,486
30	AMERISOUTH	RESIDENTIAL	3572 WILHURT	75216	211,437	355,321	0	0	211,437	355,321
31	OP&F ST ANDREWS PENSION TR	RESIDENTIAL	9001 MARKVILLE	75243	196,433	2,414,449	12,435	52,679	208,868	2,467,128
32	CHILDRENS MED CENTER	HOSPITAL	1935 MOTOR	75235	205,429	348,825	3,222	18,714	208,651	367,539
33	HYATT REGENCY DALLAS	HOTEL	308 REUNION	75207	196,576	269,428	8,495	25,894	205,071	295,322
34	PERFORMANCE PROPERTIES LLC	RESIDENTIAL	1925 MOSER	75206	203,512	287,405	0	0	203,512	287,405
35	CRESCENT DEVELOPMENT	RESIDENTIAL	2200 CEDAR SPRINGS	75201	191,618	276,017	11,726	38,496	203,344	314,513
36	DALLAS COUNTY MUD NO. 6	SERVICE INDUSTRY	2936 HICKORY TREE	75180	203,144	351,321	0	0	203,144	351,321

TABLE 8-2
MAJOR WATER USERS (>50,000 GPD) (All flows in GPD)

					Domestic Water Usage (GPD)		Irrigation Usage (GPD)		Total Water Usage (GPD)	
	Name	Customer Type	Service Address	Zip	Average	Peak Flow	Average	Peak Flow	Average	Peak Flow
37	SOUTHWESTERN BELL	SERVICE INDUSTRY	301 S AKARD	75201	198,799	314,383	1,734	4,524	200,533	318,907
38	G A F CORPORATION	MANUFACTURING	2600 SINGLETON	75212	198,305	298,481	0	0	198,305	298,481
39	APT OPPORTUNITY FUND II LP	RESIDENTIAL	9744 FOREST	75243	178,422	303,844	18,865	46,093	197,287	349,937
40	AMERICANA FOODS	FOOD PRODUCTION	3333 DAN MORTON	75236	195,290	338,966	0	0	195,290	338,966
41	ALLIANCE FH PORTFOLIO LP	RESIDENTIAL	6001 SKILLMAN	75231	184,862	320,060	1,493	14,868	186,355	334,928
42	TVO ARBORS PARTNERS LP	RESIDENTIAL	7867 WILLOW HILL	75230	166,827	410,572	17,150	90,891	183,977	501,463
43	302 TRAILS LP	RESIDENTIAL	3159 CHAPEL CREEK	75220	182,074	409,071	408	8,038	182,482	417,109
44	MACERICH VALLEY VIEW LTD	SERVICE INDUSTRY	13131 PRESTON	75240	181,397	474,161	0	0	181,397	474,161
45	FOREST SUN CHANCELLOR LP	SERVICE INDUSTRY	9422 FOREST SPRINGS	75243	179,325	265,002	542	4,258	179,867	269,260
46	EXTEX LAPORTE	POWER GENERATION	2233 MOUNTAIN CREEK	75211	179,116	379,782	0	0	179,116	379,782
47	WILDFLOWER II	RESIDENTIAL	8515 PARK	75231	134,655	240,485	41,194	153,730	175,849	394,215
48	LA/DAV APTS INC	RESIDENTIAL	14606 DALLAS	75254	173,161	261,885	1,053	3,021	174,214	264,906
49	PRESTON PARK ASSOC	RESIDENTIAL	12826 NOEL	75230	160,884	348,047	10,857	24,493	171,741	372,540
50	STEVENS CREEK ASSOC	RESIDENTIAL	700 N PEARL	75201	158,592	228,513	8,524	23,142	167,116	251,655
51	FAIRMONT DALLAS HOTEL	HOTEL	1727 N AKARD	75201	166,454	237,252	0	0	166,454	237,252
52	PRESTONWOOD COUNTRY CLUB	IRRIGATION	15909 PRESTON	75248	11,960	16,724	154,329	464,177	166,289	480,901
53	CRESENT REAL ESTATE	RESIDENTIAL	1700 N FIELD	75202	164,847	216,348	0	0	164,847	216,348
54	NATIONAL LINEN SERV	SERVICE INDUSTRY	620 YORKTOWN	75208	161,060	202,902	0	0	161,060	202,902
55	BENT TREE COUNTRY CL	IRRIGATION	5201 WESTGROVE	75248	155,316	1,387,476	5,554	19,186	160,870	1,406,662
56	TERRACE PARTNERS LP	SERVICE INDUSTRY	8617 MC KAVETT	75238	160,016	283,575	0	0	160,016	283,575
57	FANNIE MAE	RESIDENTIAL	8201 FAIR OAKS	75231	135,164	252,250	24,767	73,883	159,931	326,133
58	CITY DLS PARKS	SERVICE INDUSTRY	1770 W COLORADO	75208	26,792	128,008	131,640	709,855	158,432	837,863
59	CITY DLS PARKS	SERVICE INDUSTRY	1200 2ND	75210	79,516	532,724	75,046	712,209	154,562	1,244,933
60	HONEYCREEK KIWI, LLC	RESIDENTIAL	11611 FERGUSON	75228	154,504	282,083	0	0	154,504	282,083
61	PRESBYTERIAN VILLAGE	RESIDENTIAL	8544 SKYLINE	75243	81,023	153,793	71,924	188,299	152,947	342,092
62	DALLAS HOUSING AUTH 9-5/6	RESIDENTIAL	4900 HATCHER	75210	152,549	237,485	0	0	152,549	237,485
63	AOF/DFW AFFORDABLE HOUSING	RESIDENTIAL	8215 MEADOW	75231	137,585	249,669	13,942	25,263	151,527	274,932
64	FRANKEL EDWARD B FAMILY TR	RESIDENTIAL	4500 PEAR RIDGE	75287	79,410	151,355	69,384	140,969	148,794	292,324
65	CITY DLS PARKS - ARBORETUM	SERVICE INDUSTRY	8617 GARLAND	75218	13,294	37,098	135,189	599,441	148,483	636,539
66	Y & O TERRACE LLC	RESIDENTIAL	4539 LAKE	75219	146,340	314,127	0	0	146,340	314,127
67	TRIZEC PROP INC	RESIDENTIAL	1201 ELM	75202	142,520	215,878	0	0	142,520	215,878
68	GERALD HINES INTEREST	SERVICE INDUSTRY	13350 DALLAS	75240	142,337	232,784	0	0	142,337	232,784
69	ASPENTREE CONS CAP EQUIT	RESIDENTIAL	11661 DENNIS	75229	141,200	390,110	0	0	141,200	390,110
70	NOEL PROPERTY MGMT	RESIDENTIAL	13354 EMILY	75240	140,128	270,172	0	0	140,128	270,172
71	BAYPORT FOXMOOR ASSOC	SERVICE INDUSTRY	10843 N CENTRAL	75231	139,562	224,170	0	0	139,562	224,170
72	DALLAS BAPTIST UNIVERSITY	SERVICE INDUSTRY	7777 W KIEST	75211	138,863	302,670	0	0	138,863	302,670
73	CROW -EQUITABLE-NISSEI	OFFICE BUILDING	2200 ROSS	75201	137,038	189,468	0	0	137,038	189,468
74	REDDY ICE LTD	FOOD PRODUCTION	4320 DUNCANVILLE	75236	0	0	134,361	284,147	134,361	284,147

TABLE 8-2
MAJOR WATER USERS (>50,000 GPD) (All flows in GPD)

					Domestic Water Usage (GPD)		Irrigation Usage (GPD)		Total Water Usage (GPD)	
	Name	Customer Type	Service Address	Zip	Average	Peak Flow	Average	Peak Flow	Average	Peak Flow
75	WENTWOOD HARVEST HILL LP	SERVICE INDUSTRY	4017 HARVEST HILL	75244	133,022	222,973	0	0	133,022	222,973
76	DALLAS HOUSING AUTH 9-3/12	RESIDENTIAL	2703 LUCAS	75219	131,088	171,009	89	342	131,177	171,351
77	HARSHAW ASSET CORP	SERVICE INDUSTRY	1258 WESTMOUNT	75211	130,179	261,610	657	2,482	130,836	264,092
78	CANDLEWYCK ASSOCIATES LTD	RESIDENTIAL	9737 AMBERTON	75243	123,535	203,937	7,010	31,779	130,545	235,716
79	DEVONSHIRE REAL ESTATE	RESIDENTIAL	11040 KINGSLEY	75238	129,332	212,255	1,101	15,916	130,433	228,171
80	LOFTUS STEVE	RESIDENTIAL	11457 DENNIS	75229	129,982	315,123	0	0	129,982	315,123
81	SOUTHWEST AIRLINES	SERVICE INDUSTRY	2702 LOVE FIELD	75235	92,989	470,173	36,128	130,314	129,117	600,487
82	DALLAS CHAUCER I	RESIDENTIAL	7575 CHAUCER	75237	123,389	233,499	4,861	32,736	128,250	266,235
83	ATTILA CONSTRUCTION CO	SERVICE INDUSTRY	9461 WEBB CHAPEL	75220	126,604	286,195	0	0	126,604	286,195
84	CUSHMAN & WAKEFIELD	OFFICE BUILDING	901 MAIN	75202	66,673	88,968	59,559	110,837	126,232	199,805
85	BROCK APTS PARTNERS LP NCA	RESIDENTIAL	3008 VALLEY MEADOW	75220	115,707	293,693	3,009	12,342	118,716	306,035
86	FATH HARRY J	RESIDENTIAL	9636 FOREST	75243	86,964	160,613	31,217	117,197	118,181	277,810
87	AMERISOUTH V LTD	RESIDENTIAL	2508 COOMBS CREEK	75211	101,315	198,436	16,610	27,291	117,925	225,727
88	THANKSGIVING TOWER ASSOC	SERVICE INDUSTRY	1601 ELM	75201	117,735	162,243	0	0	117,735	162,243
89	MOUNTAIN VALLEY 2002, LP	FOOD PRODUCTION	5875 MOUNTAIN VALLE	75211	103,770	286,836	13,683	25,447	117,453	312,283
90	CEI GROUP DBA	SERVICE INDUSTRY	8023 CHARIOT	75227	117,325	184,540	0	0	117,325	184,540
91	EQUITY RESIDENTIAL PROP	RESIDENTIAL	19002 DALLAS	75287	104,833	206,685	10,794	34,278	115,627	240,963
92	PRICE PRESTON PARK LP	RESIDENTIAL	5801 SPRING VALLEY	75254	96,255	182,471	17,590	54,102	113,845	236,573
93	DOUBLETREE HOTEL	HOTEL	5410 L B J	75240	93,729	124,527	18,934	52,507	112,663	177,034
94	DALLAS ATHLETIC CLUB	SERVICE INDUSTRY	4111 LA PRADA	75228	26,565	72,355	83,769	256,176	110,334	328,531
95	TRAMMEL CROW	RESIDENTIAL	7272 MARVIN D LOVE	75237	106,978	217,387	0	0	106,978	217,387
96	GIDDENS HARVEY	RESIDENTIAL	3747 DIXON	75210	106,722	178,867	0	0	106,722	178,867
97	EVERGREEN ALLIANCE GOLF LT	IRRIGATION	6 LAKE PARK	75225	0	0	106,034	941,721	106,034	941,721
98	WAK MANAGEMENT CO	RESIDENTIAL	2755 E LEDBETTER	75216	103,341	166,215	1,306	6,352	104,647	172,567
99	PRESBYTERIAN HOSPITAL	HOSPITAL	8210 WALNUT HILL	75231	79,208	200,513	24,470	59,212	103,678	259,725
100	TRIVEST RIDGETREE LP	RESIDENTIAL	9340 SKILLMAN	75243	89,779	155,508	13,082	60,120	102,861	215,628
101	RIDGE CREST LTD	SERVICE INDUSTRY	5606 PLUM GROVE	75211	102,418	220,218	0	0	102,418	220,218
102	FANNIE MAE	RESIDENTIAL	3211 CHAPEL CREEK	75220	101,114	246,023	0	0	101,114	246,023
103	TRACY ISHINO	SERVICE INDUSTRY	9311 FOREST	75243	97,591	170,183	2,827	12,539	100,418	182,722
104	OCCIDENTAL CHEMICAL CORP	MANUFACTURING	8800 S CENTRA	75241	99,799	200,239	0	0	99,799	200,239
105	OCCIDENTAL CHEMICAL CORP	MANUFACTURING	1100 LENWAY	75215	0	0	99,757	200,219	99,757	200,219
106	DALLAS AREA RAPID TRANSIT	SERVICE INDUSTRY	2424 COMMUNITY	75220	99,097	296,650	0	0	99,097	296,650
107	CITY DLS PARKS	SERVICE INDUSTRY	3707 SAMUELL	75228	8,748	57,502	85,464	365,250	94,212	422,752
108	APT OPPORTUNITY FUND II LP	RESIDENTIAL	14100 MONTFORT	75254	89,970	141,010	3,135	17,661	93,105	158,671
109	LAKEWOOD COUNTRY CLUB	IRRIGATION	6416 GASTON	75214	13,761	18,332	79,318	322,100	93,079	340,432
110	APPLE RESIDENTIAL INCOME	RESIDENTIAL	3773 TIMBERGLEN	75287	73,814	136,441	19,151	43,523	92,965	179,964
111	PARK CENTRAL DEV	SERVICE INDUSTRY	7849 BANNER	75251	92,208	118,188	0	0	92,208	118,188
112	FANNIE MAE	RESIDENTIAL	9505 ROYAL	75243	87,902	164,312	3,702	14,167	91,604	178,479

TABLE 8-2
MAJOR WATER USERS (>50,000 GPD) (All flows in GPD)

	Name	Customer Type	Service Address	Zip	Domestic Water Usage (GPD)		Irrigation Usage (GPD)		Total Water Usage (GPD)	
					Average	Peak Flow	Average	Peak Flow	Average	Peak Flow
113	CAMDEN PROPERTY TRUST	RESIDENTIAL	9600 GOLF LAKES	75231	87,444	138,808	0	0	87,444	138,808
114	THURMAN APTS OF DALLAS	RESIDENTIAL	13552 MAHAM	75240	85,813	129,899	0	0	85,813	129,899
115	VETERANS ADMINISTRATION	HOSPITAL	2750 MOUNTAIN CREEK	75211	803	1,358	84,910	266,243	85,713	267,601
116	PRESTON TOWER CONDO	RESIDENTIAL	6211 W NORTHWEST	75225	74,748	91,207	10,942	21,616	85,690	112,823
117	CAMDEN PROPERTY TRUST	RESIDENTIAL	18250 MARSH	75287	61,897	116,396	21,458	61,210	83,355	177,606
118	LINCOLN PROPERTIES	RESIDENTIAL	19251 PRESTON	75252	53,586	120,210	29,204	67,017	82,790	187,227
119	FIRST NATIONAL BANK	SERVICE INDUSTRY	1414 PACIFIC	75202	81,533	146,292	0	0	81,533	146,292
120	EASTERN HILLS C CLUB	IRRIGATION	3000 COUNTRY CLUB	75043	0	0	80,064	643,302	80,064	643,302
121	DALLAS HOUSING AUTH	RESIDENTIAL	3535 MUNGER	75204	78,255	228,360	0	0	78,255	228,360
122	FATH HARRY J	RESIDENTIAL	10951 STONE CANYON	75230	73,618	201,323	2,701	17,300	76,319	218,623
123	DALLAS HOUSING AUTH 9-47	RESIDENTIAL	1003 SHADYSIDE	75223	75,314	129,669	0	0	75,314	129,669
124	CITY DLS PARKS	SERVICE INDUSTRY	2323 N JIM MILLER	75227	3,742	7,788	71,549	427,653	75,291	435,441
125	AMERISOUTH XX	RESIDENTIAL	7045 VILLAGE STAR	75217	74,951	124,339	0	0	74,951	124,339
126	W J GROUP I LTD	RESIDENTIAL	220 E OVERTON	75216	60,464	99,160	14,218	25,141	74,682	124,301
127	AMLI RESIDENTIAL	RESIDENTIAL	7421 FRANKFORD	75252	57,550	162,431	16,783	55,879	74,333	218,310
128	CITY DLS PARKS	SERVICE INDUSTRY	2057 VAN CLEAVE	75216	3,409	31,556	68,859	362,161	72,268	393,717
129	CAMDEN PROPERTY TRUST	RESIDENTIAL	520 FARMERS MARKET	75201	71,683	180,177	0	0	71,683	180,177
130	DALLAS HOUSING AUTH 9-43	RESIDENTIAL	5905 HIGHLAND VILLA	75241	70,475	121,361	0	0	70,475	121,361
131	CITY DLS PARK #5090	SERVICE INDUSTRY	4800 W LAWTHER	75214	11,662	69,123	58,132	352,846	69,794	421,969
132	CAMDEN PROPERTY TRUST	RESIDENTIAL	7220 MC CALLUM	75252	64,905	147,211	3,768	13,318	68,673	160,529
133	AVIALL OF TEXAS INC	SERVICE INDUSTRY	6114 FOREST PARK	75235	66,926	105,442	0	0	66,926	105,442
134	WAK MANAGEMENT CO	RESIDENTIAL	2403 BAHAMA	75211	66,861	112,016	0	0	66,861	112,016
135	CITY DLS PARKS	SERVICE INDUSTRY	5808 EAST GRAND	75223	27,623	183,991	32,585	286,938	60,208	470,929
136	NUSSBAUM FAMILY PRTNRS IV	RESIDENTIAL	9640 TIMBERLINE	75220	58,253	157,088	0	0	58,253	157,088
137	THURMAN APTS OF DALLAS	RESIDENTIAL	5000 SAMUELL	75228	58,231	78,141	0	0	58,231	78,141
138	CITY DLS PARK #5010	SERVICE INDUSTRY	7630 GREENVILLE	75231	2,143	15,768	53,942	400,438	56,085	416,206
139	ADOLPHUS ASSOCIATES	SERVICE INDUSTRY	1309 COMMERCE	75202	54,400	76,277	0	0	54,400	76,277
140	W J GROUP I LTD	RESIDENTIAL	3880 S BECKLEY	75224	50,975	75,272	751	3,294	51,726	78,566
141	CITY DLS PARKS	SERVICE INDUSTRY	12200 GARLAND	75218	4,822	32,851	45,287	252,024	50,109	284,875

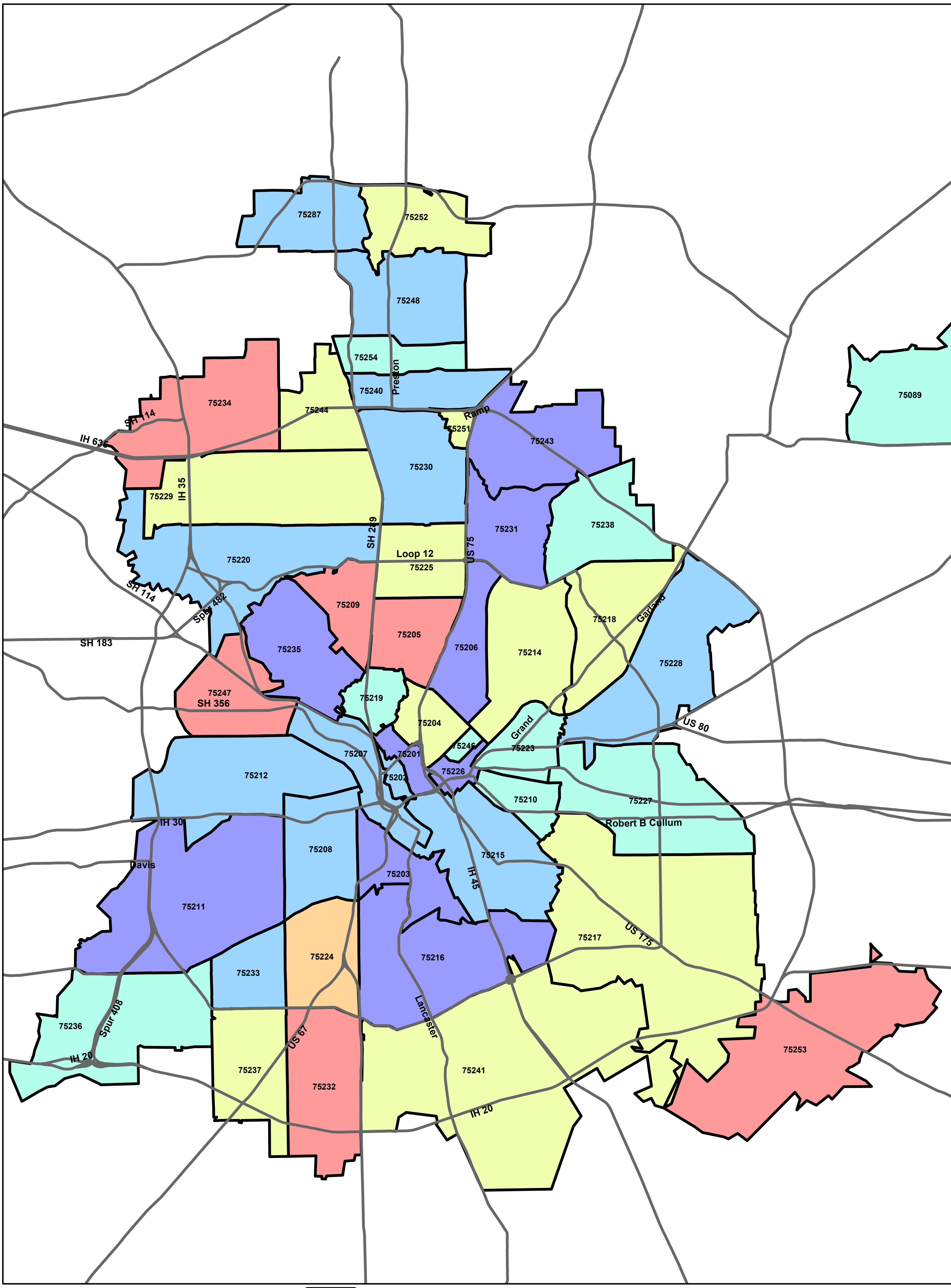
TABLE 8-3
WATER USAGE BY ZIP CODE

Zip Code	Average Flow (GPD)	Peak Flow (GPD)
75243	6,153,890	14,648,387
75235	2,454,863	5,854,307
75231	1,734,514	3,842,027
75201	1,392,089	2,522,053
75203	1,371,912	2,603,161
75206	1,364,924	2,851,673
75211	1,360,971	3,292,686
75226	1,332,196	1,698,484
75216	1,075,852	2,005,883
75248	984,435	4,165,523
75207	847,990	1,771,592
75230	833,975	1,746,552
75240	812,683	1,644,327
75220	802,056	2,148,218
75233	793,723	1,168,757
75287	787,592	1,706,684
75215	672,023	1,255,469
75202	606,806	1,044,519
75212	581,065	1,355,943
75208	572,569	1,461,485
75228	542,477	1,414,133
75246	497,526	1,421,894
75223	479,602	1,177,570
75227	455,022	1,006,046
75210	419,715	1,693,153
75254	403,295	821,302
75089	382,978	4,481,533
75236	378,603	777,821
75238	360,688	751,440
75219	321,428	783,034
75229	294,943	857,744
75237	291,666	602,529

TABLE 8-3
WATER USAGE BY ZIP CODE
(continued)

Zip Code	Average Flow	Peak Flow
75252	289,848	714,284
75218	249,653	1,028,719
75214	242,494	912,885
75261	224,483	356,758
75241	218,108	20,691
75225	213,948	1,117,568
75180	203,144	351,321
75217	177,709	440,467
75251	175,452	322,391
75204	140,031	408,591
75244	136,624	236,614
75224	81,906	290,006
75043	80,064	643,302
75234	41,843	90,993
75209	37,881	94,914
75247	30,079	94,865
75056	26,247	286,527
75253	19,351	52,153
75232	18,756	81,123
75249	16,726	74,253
75205	3,028	32,672

(This page intentionally left blank)



Average Water Usage (gpd)

- 3028 - 50000
- 50001 - 100000
- 100001 - 300000
- 300001 - 500000
- 500001 - 1000000
- 1000001 - 7000000

N

0 14,000 Feet

FIGURE 8-2

DALLAS WATER UTILITIES
RECYCLED WATER IMPLEMENTATION PLAN
MAJOR CUSTOMERS BY ZIP CODE

dallas water utilities

apaienv.com

CP&Y

(This page intentionally left blank)

TABLE 8-4
FIVE GENERAL AREAS WITH MAJOR CUSTOMERS USING IN EXCESS OF 1 MGD

Area	Zip Code	Average Flow	Major Customers
East side of the North Central Expressway Corridor from Henderson north to the City of Richardson	75243 75231 75206	9.25 MGD	Texas Instruments Lincoln Properties OP&F St Andrews Pension Trust APT Opportunity Fund II LP Thurman Apts of Dallas Harry J Fath Fannie Mae Performance Properties LLC City of Dallas Parks
Central Business District	75201 75226	2.72 MGD	Pilgrim's Pride Adam's Mark Hotel Crescent Development Southwestern Bell
Love Field Area from Loop 12 south to Oak Lawn	75235	2.45 MGD	UT Southwestern Medical Center Brook Hollow Golf Club John F. Firestone Children's Medical Center
Area bounded by IH35E, Loop 12, IH45 & the Trinity River floodway	75203 75216	2.45 MGD	Rock Tenn Veterans Administration City of Dallas Parks Amerisouth Ltd.
Southwest Dallas bounded by Hampton, Ledbetter, IH30 and Mountain Creek	75211	1.36 MGD	Dallas National Golf Club Amerisouth Ltd

8.2.3 Proposal to Obtain Additional Information

The types of usage of the major water customers are of primary importance in the determination of potential recycled water customers. After the desktop evaluation was performed, many questions regarding the usage still remain unanswered. More reliable information should be obtained by contacting the customer directly, either through telephone contacts or by utilizing a standard letter and questionnaire. A standard transmittal letter and questionnaire have been developed for distribution to select major water customers, (see Appendices E and F), respectively. Analysis of the responses to the questionnaire will provide a more reliable basis for determining viable potential recycled water customers.

8.3 City-Owned Facilities

As a first step in implementing a recycled water program, it would be prudent to provide recycled water to City-owned facilities. Such is the case in the City's first recycled water project - the Cedar Crest Golf Course irrigation project, online 2004.

As a follow-up to this approach, a recycled water analysis program was developed to identify DWU-owned facilities and private golf courses. Dallas Water Utilities provided a listing of water metering data for City-owned facilities for the time period from February 2002 through October 2003. Data were evaluated to determine which facilities might be potential candidates for recycled water service. The major water users are listed in Table 8-5.

TABLE 8-5
MAJOR CITY-OWNED GOLF COURSES, PARKS, AND THE ZOO

City-Owned Facilities	Peak Flow (GPD)
Fair Park	1,244,933
Dallas Zoo	1,117,209
Samuel Grand/Tenison Park Golf Course	893,681*
Stevens Park Golf Course	837,863
White Rock Lake (East Side)	674,604
Arboretum	636,539
Cedar Crest Golf Course	446,451
White Rock Lake (West Side)	421,969
Fair Oaks Park	416,206
Keeton Park Golf Course	389,865
Samuel Garland Park	284,875

* Partial Raw Water Service

8.4 DWU Raw Water Supply

The potential for utilizing large volumes of recycled water to augment raw water supplies is being addressed as a supplement to the current project and will be presented in Volume 2 of this report.

8.5 Dallas Trinity River Project

The planned Trinity River Project could require up to a 50-MGD water supply. It has been proposed that the water requirement be met with wastewater treatment plant effluent. Providing the effluent to meet this need may require obtaining an additional Total Pollutant Discharge Elimination System (TPDES) permit from the TCEQ. Obtaining this additional discharge permit could affect the water quality discharge criteria for the Central WWTP. A determination of whether additional treatment would be required should be assessed using a mathematical water quality model that has been calibrated for the Trinity River.

8.6 Privately-Owned Developments and Golf Courses

In addition to the City's parks and golf courses, there are numerous privately owned developments and golf courses in the City of Dallas. There is a potential to provide recycled water for these irrigation projects. A "drought-proof" resource of irrigation supply could be very attractive to the owners. Table 8-6 lists the largest water users for private golf courses.

TABLE 8-6
Private Golf Courses

Private Golf Courses	Peak Flow (GPD)
Waterview Development	4,481,533*
Preston Trails Golf Course	1,910,532*
Bent Tree Country Club	1,479,003*
Evergreen Alliance Golf Course	941,721*
Prestonwood Country Club	896,042*
Brook Hollow Golf Club	813,580*
Dallas National Golf Course	775,930
Eastern Hills C Club	643,302*
Lakewood Country Club	362,032
The Golf Center of Dallas	137,168
Northwood Country Club	39,508

* Raw Water Service

8.7 Industrial Users/Uses

Industrial water users that may be potential recycled water customers are listed in Table 8-2 as "manufacturing" or "power generation" in the Customer Type column. The potential for these water customers to be served by a recycled water project is discussed further in Chapter 9.

(This page intentionally left blank)

CHAPTER 9

RECYCLED WATER SERVICE AREAS AND POTENTIAL PROJECTS

9.1 Introduction

This chapter presents information regarding potential recycled water customers, potential service areas, conceptual designs of recycled water systems served by satellite water factories, and conceptual designs of recycled water systems served by the existing wastewater treatment plants. The information developed in this chapter serves as the basis of the feasibility analyses performed in Chapter 10.

9.2 Potential Recycled Water Customers

In order to determine the viability of a market for the sale of recycled water, an analysis of potential individual customers for recycled water was required. The sale of recycled water to individual customers is a primary application of recycled water. The process utilized to identify specific potential customers was evaluation of the City of Dallas's water customer database (Chapter 8). Average and peak daily water usage for domestic water consumption and irrigation and water consumption by zip codes and type of usage were utilized in evaluating the viability of potential recycled water customers.

The initial focus for recycled water uses by the City of Dallas is Type II applications, where incidental contact with humans is not likely to occur. As a result of this initial focus on Type II applications, irrigation of residences, parks, and other uses requiring Type I water were not considered for the initial projects. However, it is anticipated that if DWU commits to a Type I water quality the customer base would expand in the future to provide recycled water to users requiring the higher quality water.

The major Type II recycled water customers and City-owned facilities were evaluated to identify the most likely candidates for recycled water usage. Once identified, these candidates were grouped by zip code. This step enabled general areas of the City of Dallas to be identified as potential recycled water service areas.

Based on the analysis of major water customers and City-owned facilities as described in Chapter 8, potential recycled water customers were identified. Table 9-1 contains a listing of the larger potential recycled water customers.

9.3 Services Areas

Individual projects to serve the potential customers were conceptualized and grouped together to form recycled water service areas. Five recycled water service areas were identified:

1. Cedar Crest Corridor Service Area
2. Lower White Rock Service Area
3. Upper White Rock Service Area
4. Love Field Service Area
5. Southwest Dallas Service Area

Table 9-1
Potential Recycled Water Customers (Large Users)

Type	Potential Customer	Zip Code	Peak Flow (GPD)
Manufacturing	Texas Instruments	75243	9,957,437
Medical	U T Southwestern Medical Center	75235	3,291,009
Apartments	Lincoln Properties (Village Apartments)	75206	2,338,710
Golf Private	Preston Trails Golf Course	75248	1,910,532
Golf Private	Bent Tree Country Club	75248	1,479,003
Park	Fair Park	75210	1,244,933
Manufacturing	Rock-Tenn	75203	1,241,606
Park	Dallas Zoo	75203	1,117,209
Golf Private	Evergreen Alliance Golf	75225	941,721
Golf Private	Prestonwood Golf Club	75248	896,042
Golf Public	Samuel Grand/Tenison Park Golf Course	75223	893,681
Golf Public	Stevens Park Golf Course	75208	837,863
Golf Private	Brook Hollow Golf Club	75235	813,580
Golf Private	Dallas National Golf	75211	775,930
Park	White Rock Lake (East Side)	75218	674,604
Park	Arboretum	75218	636,539
Business	Southwest Airlines	75235	600,487
Golf Public	Cedar Crest Golf Course	75216	446,451
Golf Public	Grover Keeton Golf Course	75227	435,441
Park	White Rock Lake (West Side)	75214	421,969
Park	Fair Oaks	75231	416,206
Medical	Medical City Dallas	75230	396,766
Business	Extex Laporte Electrical Power Plant	75211	379,782
Medical	Childrens Medical Center	75235	367,539
Golf Private	Lakewood Country Club	75214	362,032
Golf Private	Dallas Athletic Club	75228	328,531
Business	Dallas Baptist University	75211	302,670
Park	Samuel Garland	75218	284,875
Commercial	Park Central Development	75251	270,085
Medical	Veterans Administration	75211	267,601
Golf Private	Royal Oaks Golf Course	75231	137,458
Golf Private	The Golf Center of Dallas	75231	137,168
Park	Kidd Springs	75208	127,857
Business	Aviall of Texas	75235	105,442

Within each of these service areas, the potential Type II recycled water customers were identified, and the recycled water demand for each customer was estimated (Table 9-2). A peaking factor was applied and the resulting recycled water demand for each service area was determined. Based on this estimated demand, a recycled water system was developed for each service area.

9.4 Recycled Water Source Options

9.4.1 Water Factories

Within each service area, a determination was made regarding the source of the recycled water. In the five recycled water service areas, except the Cedar Crest Corridor Service Area, an initial determination was made to supply the service area with recycled water by utilizing a water factory. Sites for water factories were located within each service area based on the following water factory site criteria:

- Electrical power availability
- Ownership (public ownership preferred)
- Permitting (zoning, flood plain, etc.)
- Proximity to wastewater interceptor
- Proximity to potential users
- Public acceptability

Specific projects within each service area were identified and a phased construction plan for each service area developed.

With regard to water factory sites, during development of this plan "windshield surveys" were used to develop potential sites. The potential water factory sites need to be further identified and then confirmed during preliminary design, including confirmation of available land, utility availability, zoning, acceptance by adjacent landowners, etc. Pipeline alignments in the plan are conceptual with some proposed alignments paralleling existing easements. In preliminary design, the pipeline alignments need to be confirmed and easements obtained.

9.4.2 Recycled Water Supply

The recycled water source for specific service areas in the City of Dallas is either treated effluent from the two wastewater treatment plants, Central WWTP and Southside WWTP, or effluent from satellite wastewater treatment plants (water factories) located within the wastewater collection system. In order to evaluate the potential of furnishing recycled water for a service area by a water factory, it is necessary to determine the amount of wastewater flow that is available from the wastewater collection system at the location of the water factory.

TABLE 9-2 AVERAGE USAGE, SYSTEM CAPACITY AND AVERAGE SUPPLY BY SERVICE AREA				
Project		Identified Average Usage (MGD)	System Capacity (MGD)	Projected Average Supply (MGD)
Cedar Crest Pipeline				
1	Extend pipeline to Zoo, Rock-Tenn Area	1.74	3.50	1.75
2	Phase 2 to Steven Golf Course	0.31	1.00	0.50
	Total Service Area	2.05	4.50	2.25
Lower White Rock Water Factory				
1	Water Factory and PL to Arboretum	0.28	1.60	0.80
2	PL to Samuel Grand/Tenison	0.23	1.20	0.60
3	PL to Fair Park	0.19	1.50	0.75
4	PL to Lakewood Country Club	0.18	0.70	0.35
	Total Service Area	0.88	5.00	2.50
Upper White Rock Water Factory				
1	Water Factory and PL to Texas Instruments	4.80	10.70	5.35
2	PL to Fair Oaks	0.21	1.20	0.60
3	PL to Medical City	0.14	0.20	0.10
4	PL to Park Central	0.05	0.10	0.05
5	PL to The Village	1.29	2.80	1.40
	Total Service Area	6.49	15.00	7.50
White Rock Pipeline Alternate		7.37	30.00	16.50
Love Field/Medical Complex Water Factory				
1	Water Factory and PL to Medical Complex	0.83	2.20	1.10
2	PL to Brook Hollow Country Club	0.10	1.55	0.78
3	PL to DART	0.15	0.45	0.23
4	PL to Love Field	0.06	0.30	0.15
	Total Service Area	1.14	4.50	2.25
Southwest Dallas Water Factory				
1	Water Factory and PL to Dallas Golf	0.52	1.40	0.70
2	PL to Extex Laporte	0.18	0.40	0.20
3	PL to Dallas Baptist University	0.07	0.20	0.10
	Total Service Area	0.77	2.00	1.00
Total System		**11.33**	**41.00**	**22.00**

In order to determine the amount of wastewater flow in the system, data were collected from existing flow meters, which are located at specified points within the wastewater collection system. The data analysis compiled for this report was received from Dallas Water Utilities. The flow data were analyzed, and appropriate data were extracted.

Raw data were taken from the logged readings provided from the metering points. The time period for the data was from March 2003 to December 2003. Hundreds of data points were recorded for each month. Each month's data were imported into Insight, a data analysis computer program, and a database was created for each metering point. Output from the database was sent to a text file and then input into an Excel spreadsheet. The information taken from the spreadsheet included the total flow in million gallons for each day and month as well as the average total flow for each month.

Overall, the data appeared to be consistent; however a few of the data sets contained outlying values that may have occurred due to changing of meters. These outliers were disregarded.

The Dallas Water Utilities wastewater metering system is quite extensive and contains meters on most major wastewater interceptors in the City. Metering stations, located in the proximity of potential water factory sites, within each of the five service areas described below were selected. The following wastewater meters were selected: R.L. Thornton, Fair Oaks, Pentagon, and Knights Branch. The two R.L. Thornton meters are on the White Rock Interceptor at IH30. The two Fair Oaks meters are also on the White Rock Interceptor near Walnut Hill Lane. The Pentagon meter is on the Five-Mile Creek Interceptor near the intersection of Westmoreland Road and Kiest Boulevard. The Knights Branch meter is on the East Bank Interceptor near Inwood Road and IH-35E. The maximum, minimum, and average flows (in MGD) for these meters are shown in Table 9-3.

9.4.3 Existing Wastewater Treatment Plants

DWU owns and operates two wastewater treatment plants—Central and Southside. Both plants' effluents are high quality, and, at current loading rates, produce recycled water appropriate for either Type I and Type II users. Projected flows from these facilities were presented in Table 3-8.

9.5 Potential Projects and Conveyance Systems

This section describes each recycled water service area and potential projects within the service areas.

9.5.1 Cedar Crest Corridor Service Area

As an initial step in the implementation of a recycled water program, the City of Dallas is installing a recycled water pipeline from the Central Wastewater Treatment Plant to the Cedar Crest Golf Course for use in irrigation of the golf course. This project, which provides recycled water to a City-owned facility, represents a logical approach to the introduction of recycled water into the Dallas Water Utilities' system. As a follow-up to this approach, a separate analysis was made of City of Dallas-owned facilities and private golf courses.

TABLE 9-3
Metered Wastewater Flow Data
(MGD)

		DIA	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC
						MAXIMUM						
WR005	R L Thornton	72	34.779	37.389	51.477	44.596	31.861	31.311	N/A	28.776	33.621	24.553
WR006	R L Thornton	54	N/A	28.745	33.998	34.12	32.248	32.014	38.528	29.347	34.914	27.412
WR019	Fair Oaks	60	N/A	28.050	37.132	35.504	29.286	26.26	37.491	27.849	36.854	27.708
WR020	Fair Oaks	36	7.477	7.705	8.767	8.27	8.157	8.292	10.34	8.541	9.883	8.34
FM010	Pentagon	36	4.683	4.271	5.295	8.276	4.208	4.22	4.964	4.172	4.492	3.874
EB005	Knight's Branch	72	19.911	19.701	24.246	28.575	17.033	17.251	38.672	15.986	24.638	19.009
						MINIMUM						
WR005	R L Thornton	72	31.532	30.159	29.900	30.959	29.04	25.979	N/A	21.356	22.617	22.617
WR006	R L Thornton	54	N/A	27.068	23.181	26.902	27.077	26.608	26.822	25.211	23.761	22.382
WR019	Fair Oaks	60	N/A	25.309	25.128	25.915	24.367	24.102	24.255	23.887	23.331	21.047
WR020	Fair Oaks	36	6.973	6.846	6.873	4.398	4.77	7.656	7.806	7.23	7.355	6.074
FM010	Pentagon	36	3.393	3.16	3.475	3.745	3.503	3.488	3.465	3.149	3.332	3.303
EB005	Knight's Branch		15.784	15.215	14.804	15.266	14.209	13.995	14.622	1.504	14.233	14.663
						AVERAGE						
WR005	R L Thornton	72	33.110	31.944	32.531	33.170	30.882	28.040	N/A	24.314	26.019	23.866
WR006	R L Thornton	54	N/A	27.930	28.898	29.661	29.829	30.388	30.248	27.669	28.582	24.709
WR019	Fair Oaks	60	N/A	26.285	27.416	28.640	25.668	25.090	27.797	25.177	26.547	24.197
WR020	Fair Oaks	36	7.246	7.301	7.396	6.977	7.309	8.048	8.750	7.881	8.109	7.610
FM010	Pentagon	36	4.100	3.808	4.073	4.722	3.969	3.929	4.007	3.733	3.762	3.663
EB005	Knight's Branch		17.651	16.927	16.897	17.549	16.031	16.370	19.312	11.876	15.005	15.661

The Cedar Crest Corridor Service Area is located northwest of the Central Wastewater Treatment Plant. Potential recycled water customers in this service area include the Dallas Zoo, Rock Tenn (a paper products producer), Stevens Park Golf Course, and several smaller City parks. This service area could be extended further toward the west to include the Southwest Dallas Service Area, described later.

Dallas Water Utilities has initiated construction of a 20-inch recycled water pipeline from the Central Wastewater Treatment Plant to the Cedar Crest Golf Course. This pipeline, located in the right-of-way of Southerland Avenue, will provide recycled water for irrigation of Cedar Crest Golf Course. The development of the Cedar Crest Corridor Service Area is a continuation of this recycled water pipeline.

Since the recycled water is produced at the Central Wastewater Treatment Plant, the facilities required for development of this service area are a pump station and distribution piping.

- Phase I of the development of the Cedar Crest Corridor Service includes a pump station and a 20-inch pipeline in Southerland Avenue and Ewing Street from a 20-inch outlet on the Cedar Crest pipeline to the Dallas Zoo with a12-inch extension to Rock Tenn.

- Phase II is a 16-inch pipeline continuing north in Ewing Street to Eighth Street and west on Eighth Street and Davis Street to Kings Street and to Stevens Park Golf Course with a 12-inch extension to Kidds Springs Park.

There are other parks and other potential recycled water customers in this area.

See Figure 9-1 for the Cedar Crest Corridor Service Area.

9.5.2 White Rock Creek Basin

The area located east of the North Central Expressway from the Central Business District north to the City of Richardson is a significant corridor for potential recycled water customers within the City of Dallas. This corridor, which primarily parallels the White Rock Creek drainage basin, contains parks, public and private golf courses, and City facilities as well as major water customers. The project identified potential users of Type II recycled water as well as parks and other facilities that might be served with Type II water in the future.

This area has been divided into two service areas: Lower White Rock Service Area and Upper White Rock Service Area.

Lower White Rock Service Area

The Lower White Rock Service Area extends south from White Rock Lake Park to Fair Park. Potential recycled water users in this service area include various park facilities located around White Rock Lake, the Dallas Arboretum, Lakewood Country Club, Tenison Park Golf Course, Samuel Grand Park, and Fair Park. The Arboretum, located on Garland Road on the east side of White Rock Lake, would provide high public visibility for recycled water usage.

(This page intentionally left blank.)

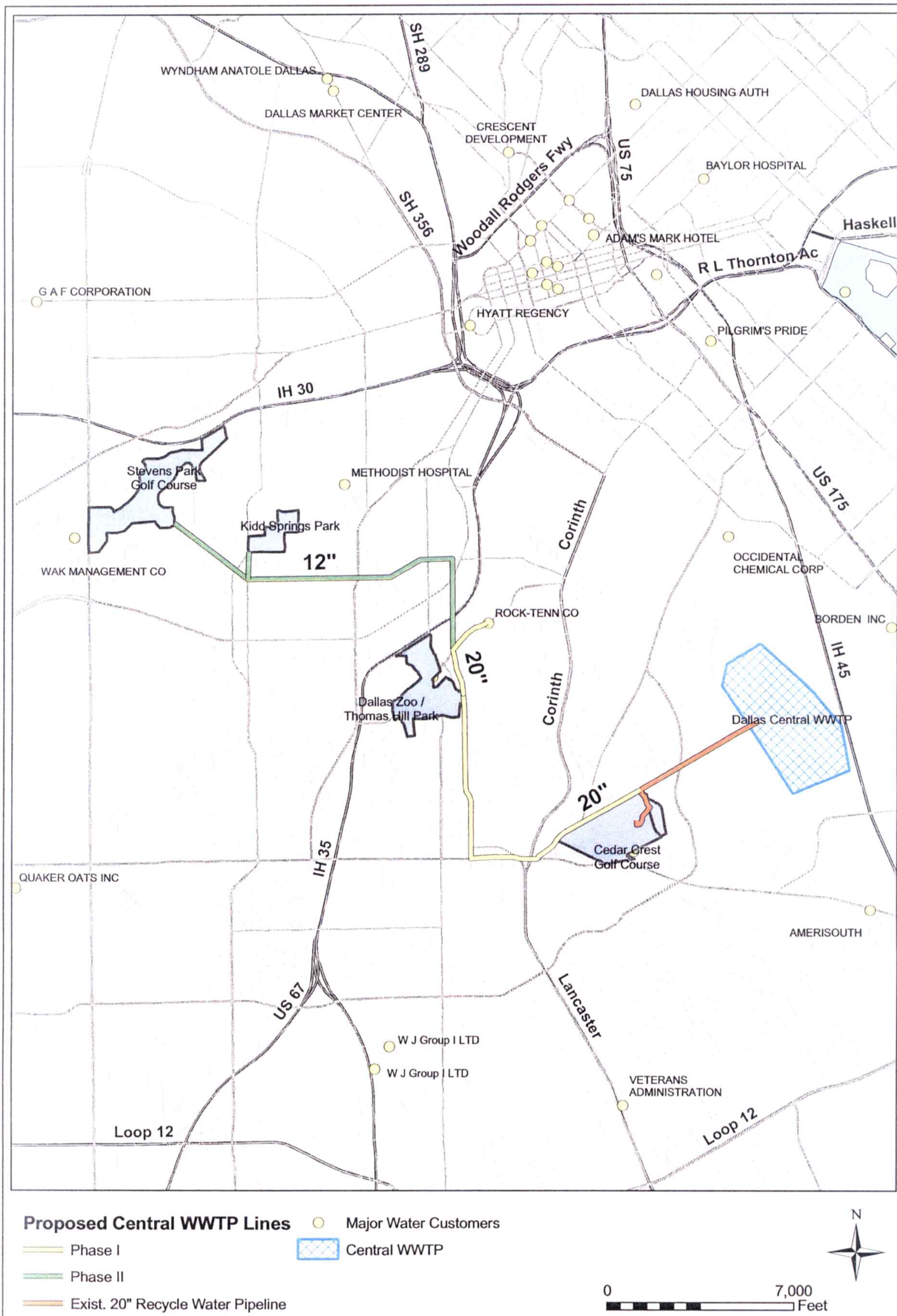


FIGURE 9-1

DALLAS WATER UTILITIES
RECYCLED WATER IMPLEMENTATION PLAN
CEDAR CREST CORRIDOR SERVICE AREA

(This page intentionally left blank.)

The development of the Lower White Rock Service Area is divided into four phases.

- Phase I is a 5.0-MGD water factory potentially located adjacent to the White Rock Pump Station/Water Operation Control Center and a 16-inch pipeline located south of White Rock Lake Dam from the Control Center to Garland Road. A 12-inch pipeline would continue north along Garland Road to the Arboretum.

- Phase II is a 16-inch pipeline along Garland Road south to Samuel Grand Park and Tenison Park Golf Course.

- Phase III is a 12-inch pipeline continuing south along Garland Road to Fair Park.

- Phase IV is a 12-inch pipeline from Garland Road to Lakewood Country Club.

See Figure 9-2 for the Lower White Rock Service Area.

Upper White Rock Service Area

The Upper White Rock Service Area is an area that extends northwest from White Rock Lake Park along the White Rock Creek basin towards Interstate Highway (IH) 635 and Richardson. Potential recycled water customers in this service area include Royal Oaks Country Club, Fair Oaks Park, the Village Apartment Complex, Texas Instruments, Medical City, the Park Central Development, Area and various park facilities along the White Rock Creek.

This service area has the greatest potential for recycled water usage in the City primarily because of Texas Instruments (TI). TI is located at the northeast corner of Central Expressway and IH-635, and is the largest water customer in the City of Dallas. The water metering data for TI had an average water demand of approximately 5 MGD with a peak demand of 10 MGD.

- Phase I of the Upper White Rock Service Area is a 15-MGD water factory located on the banks of White Rock Creek in the area south of Forest Lane and a 24-inch pipeline from this water factory northeast to TI.

- Phase II is a 20-inch pipeline from the water factory south along White Rock Creek to Fair Oaks Park and Royal Oaks Country Club. If TI is not a recycled water customer, Phase I would be deleted and a 5.0-MGD water factory would be constructed as part of Phase II.

- Phase III is a 16-inch pipeline from Fair Oaks south along Greenville Avenue to the Village Apartment complex located south of Northwest Highway.

- Phase IV is a 16-inch pipeline from the water factory north along White Rock Creek to the Medical City Complex located on Forest Lane.

- Phase V is a 12`-inch pipeline from Medical City north to the Park Central Development area.

(This page intentionally left blank.)

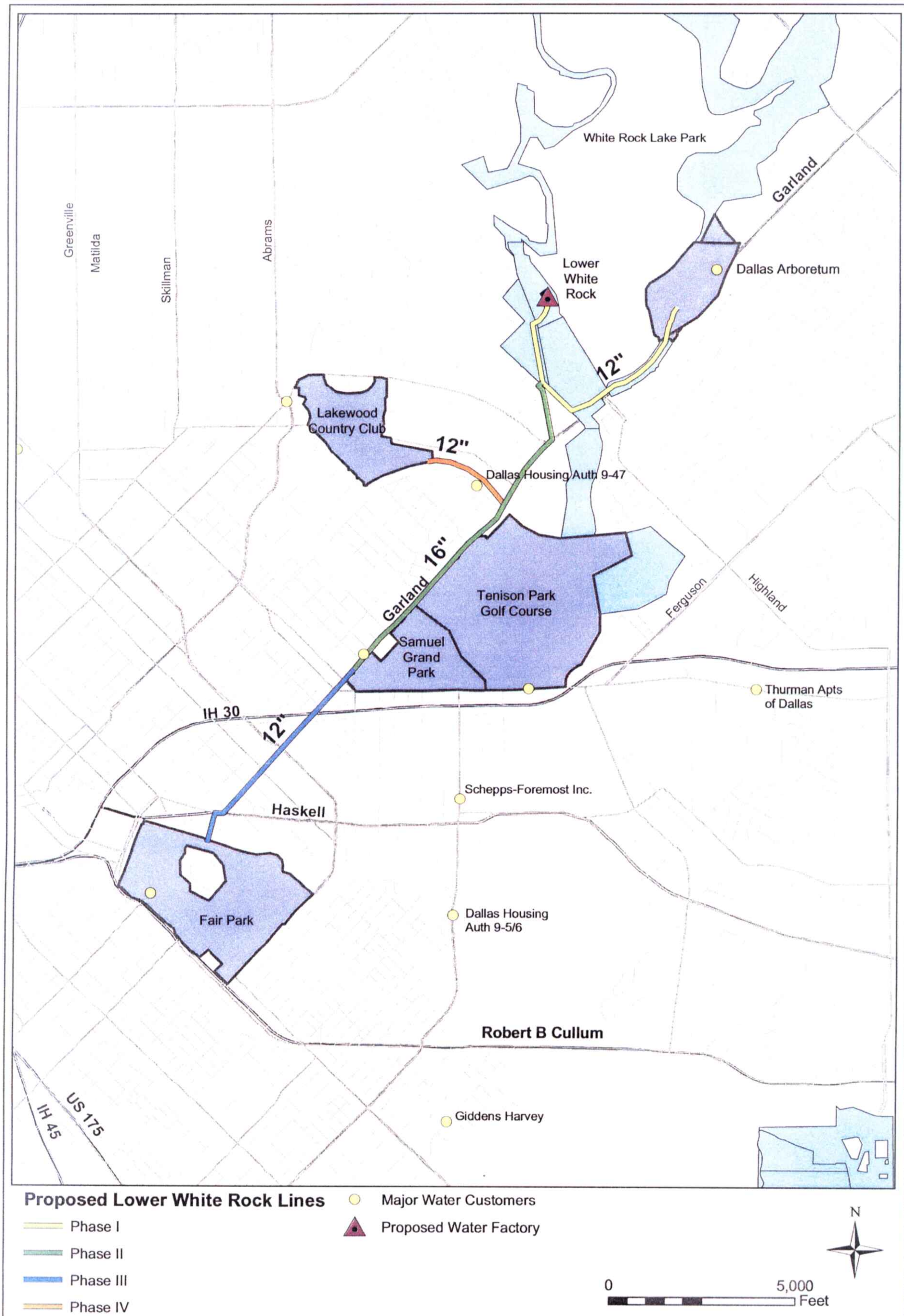


FIGURE 9-2

DALLAS WATER UTILITIES
RECYCLED WATER IMPLEMENTATION PLAN
LOWER WHITE ROCK SERVICE AREA

dallas water utilities apaienv.com CP&Y

(This page intentionally left blank.)

See Figure 9-3 for the Upper White Rock Service Area.

White Rock Pipeline Alternate

As an alternate to the development of the Upper and Lower White Rock Service Areas as described above, a pipeline could be installed in the White Rock Creek basin from the Central WWTP northward to TI and continuing on to north Dallas. This alternate would have the advantage of eliminating the need for the two water factories but would require two pump stations to pump recycled water from Central WWTP to customers in the White Rock Basin.

With the supply of recycled water originating at Central WWTP, some form of circulation or flushing would be necessary, particularly in the northern reaches of the recycled water piping, to prevent stagnation of the water supply. Flushing would present a significant operational consideration. Providing circulation would require an additional pipeline possibly located along the Trinity River and the Elm Fork from Central WWTP north to either Elm Fork WTP or continuing on to Lake Lewisville. This pipeline will be discussed as a part of water supply augmentation in Volume 2 of this report.

See Figure 9-4 for the White Rock Pipeline Alternate.

9.5.3 Love Field Service Area

The Love Field Service Area lies along the East Bank of the Trinity River from the Dallas North Tollway northwest toward Love Field Airport. Potential recycled water customers in this service area include Children's Medical Center, UT Southwestern Medical Center, Brook Hollow Country Club, Dallas Area Rapid Transit (DART) facility, and Dallas Love Field Airport.

The primary potential customer in the Love Field Area is the cooling tower facilities for the UT Southwestern Medical Center/Children's Hospital Complex located north of Harry Hines Boulevard. Brook Hollow Golf Course was initially identified as a potential recycled water customer; however, the water service to the golf course is a raw water service and is not considered to be a viable candidate for recycled water service.

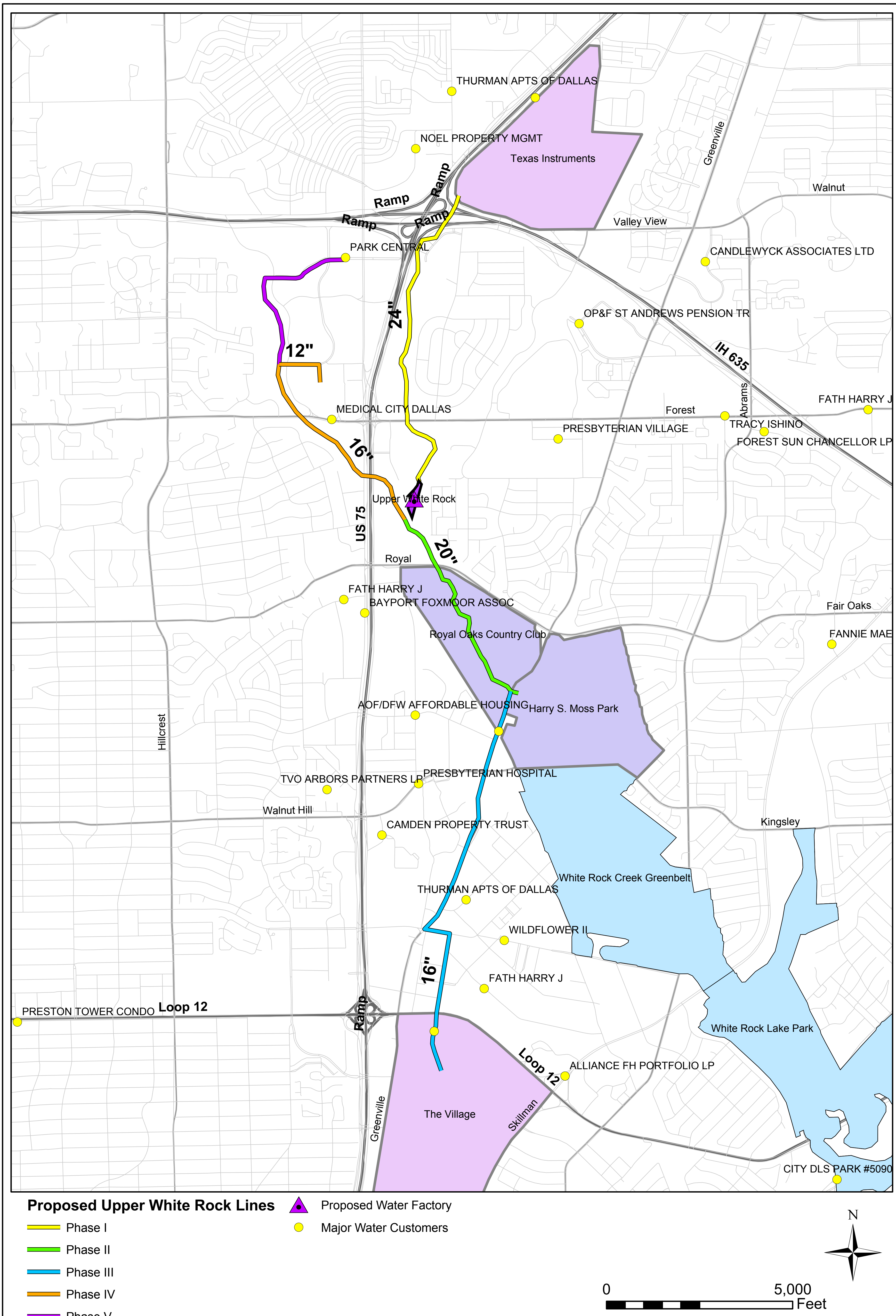
- Phase I is a 4.5 MGD water factory located on the East Bank Interceptor and a 16-inch pipeline from the water factory to the Medical Complex.

- Phase II is a 16-inch pipeline from the water factory north with a 12-inch extension to the DART facility located on Harry Hines.

- Phase III is a 12-inch pipeline to Love Field Airport.

See Figure 9-5 for the Love Field Service Area.

(This page intentionally left blank.)



FIGURE

9-3

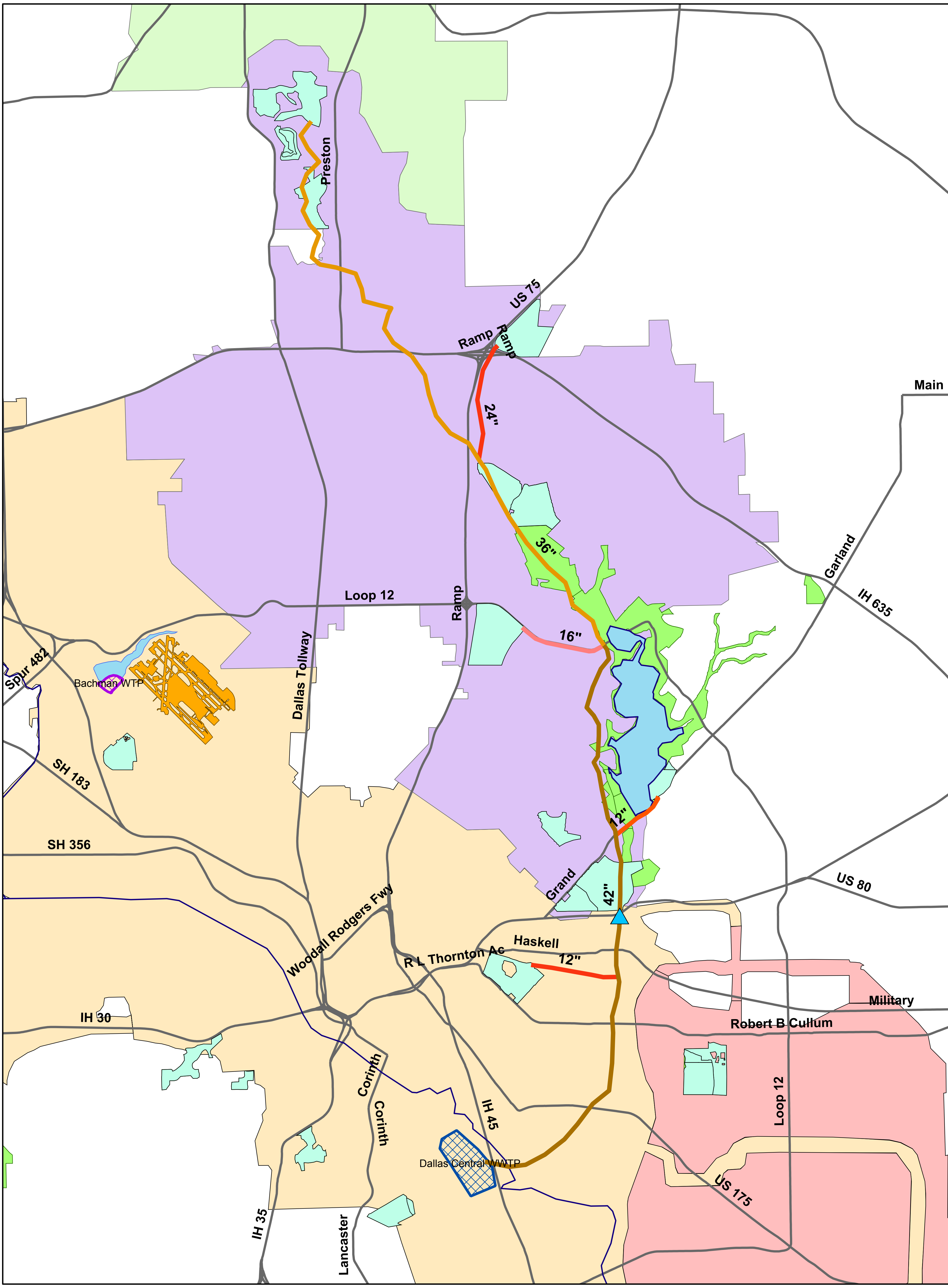
DALLAS WATER UTILITIES
RECYCLED WATER IMPLEMENTATION PLAN
UPPER WHITE ROCK SERVICE AREA

dallas water utilities

apaienv.com

CP&Y

(This page intentionally left blank.)



Legend

- Pump Station
- Meandering Way High Pressure Zone
- North High Pressure Zone
- Pleasant Grove Intermediate Pressure Zone
- Central Low Pressure Zone

0 16,000 Feet

N

FIGURE

9-4

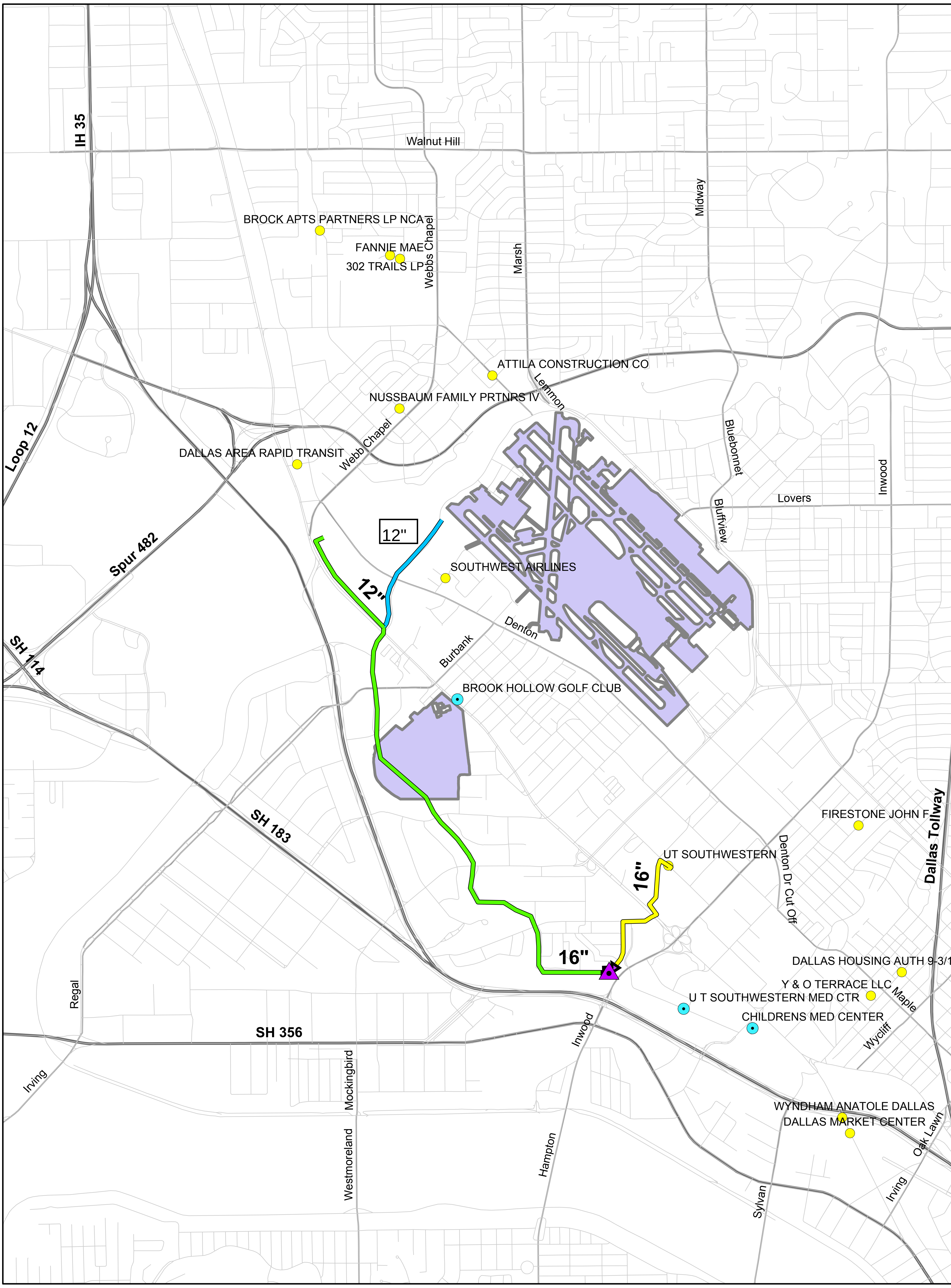
DALLAS WATER UTILITIES
RECYCLED WATER IMPLEMENTATION PLAN
WHITE ROCK PIPELINE ALTERNATIVE

dallas water utilities

apaienv.com

CP&Y

(This page intentionally left blank.)



Proposed Love Field Lines

- Love Field, Phase I
- Love Field, Phase II
- Love Field, Phase III

- Major Water Customers
- Proposed Water Factory

N

0 6,000 Feet

FIGURE 9-5

DALLAS WATER UTILITIES
RECYCLED WATER IMPLEMENTATION PLAN
LOVE FIELD SERVICE AREA

dallas water utilities

apaienv.com

CP&Y

(This page intentionally left blank.)

9.5.4 Southwest Dallas Service Area

The Southwest Dallas Service Area is an area bounded generally by U.S. Highway 67, U.S. Highway 80, and Mountain Creek Lake. The potential customers identified in the Southwest Dallas Service Area include the Dallas National Golf Club, Extex Laporte (a power plant), and Dallas Baptist University.

The wastewater flow in the Five-Mile Creek Interceptor was marginally close to the anticipated recycled water demand in this service area. As a result, the wastewater supply for a water factory in this area will likely need to be provided or supplemented from an alternate source. Two possible sources are diverting City of Dallas wastewater flow from the TRA wastewater interceptor or extension of the Cedar Creek Corridor Recycled Water Service Area. An extension of the recycled water pipeline from Stevens Park Golf Course into this area could provide this additional supply, which would require additional pumping.

- Phase I consists of a 5.0 MGD water factory on the Five-Mile interceptor and a 12-inch pipeline from the water factory to Dallas National Golf Club.
- Phase II is a 12-inch pipeline to the Extex-Laporte power plant.
- Phase III is a 12-inch pipeline to Dallas Baptist University.

See Figure 9-6 for the Southwest Dallas Service Area.

(This page intentionally left blank.)

Proposed Recycle Water Lines

Phase I

Phase II

Phase III

Major Water Customers

Proposed Water Factory

N

0 6,000 Feet

FIGURE

9-6

DALLAS WATER UTILITIES
RECYCLED WATER IMPLEMENTATION PLAN
SOUTHWEST DALLAS SERVICE AREA

dallas water utilities

apaienv.com

CP&Y

(This page intentionally left blank.)

CHAPTER 10

PROJECT FEASIBILITY AND RECOMMENDED PROJECTS FOR IMPLEMENTATION

10.1 Introduction

A conceptual-level feasibility analysis was performed for each of the recycled water projects and phases. This analysis included estimating capital costs, operations and maintenance costs, and energy costs for each of the projects and phases. The capital costs were amortized to calculate the annual debt service cost for each project and phase. All of these costs were expressed in unit cost ($/1000 gal) for comparison.

This analysis was based on the following evaluation assumptions:

- DWU ownership of effluent from wholesale water customers
- Zero cost for all WWTP effluent to be recycled
- Water Pricing
  - Potable Water Price: Current
  - Recycled Water Price: 75% of Potable Water
  - Raw Water Price: Current

- Water Factory: Use CPYI Typical Capital Cost vs. Capacity Curves (see below)
- Pipeline Costs: Based on Cedar Crest Pipeline Project
- Land Costs = Appraised Value
- Project Financing (for capital recovery cost)
  - Project Life = 50 years (*)
  - Financing Period = 30 years
  - Financing Rate = 5% APR
  - Cost/Benefit Inflation = Discount Rate
- Operations and Maintenance (O&M) Costs, excluding Power = 2.5% of Capital Costs
- Energy costs based on $0.06 per KWH

(*) Note: Recycled water costs are typically based on the average cost over the projected life of the project; i.e., 50 years. This average annual cost calculation includes a capital recovery period (a.k.a. financing period, or debt service period) of 30 years. O&M and energy costs are paid over the entire 50-year project life.

These project feasibility assumptions are generally consistent with the cost-estimating guidelines for Region C Regional Water Planning projects.

10.2 Typical Recycled Water Factory and Costs

In the development of recycled water service areas, one approach to producing the recycled water is to position satellite recycled water treatment plants (water factories) located among clusters of potential customers. These treatment plants divert wastewater from the existing collection system and treat it to the desired recycled water quality. Separate recycled water distribution systems distribute the recycled water to the cluster of customers.

10.2.1 Typical Water Factory Configuration

Each water factory would typically consist of a diversion structure, treatment system, storage tank, and pump station. The water factory would be located within a cluster of users that share the same pressure plane and geographic region. The distribution piping originates from each water factory site and radiates to each of the users on that particular system. The pipeline alignments generally follow existing rights-of-way such as roadways.

As mentioned, water factories receive wastewater from the collection system and treat the wastewater to the desired recycled water quality. Waste solids and other residuals are returned to the collection system; therefore, no on-site sludge storage or disposal is necessary. Discharges resulting from maintenance also return to the collection system.

10.2.2 Current Water Factory Technology

Current state-of-the-art wastewater treatment technology can produce effluent reliably meeting recycled water quality standards. Membrane bioreactor treatment systems (MBR) consistently produce a high quality effluent that complies with Type I recycled water requirements and are regularly used throughout the United States in recycled water applications. Other technologies may be more appropriate or cost-effective for water factories with higher flows. Since the facilities are operated as satellite plants, a high level of SCADA instrumentation is typically provided to minimize operator visits to the site. MBR technology was considered due to the small facility footprint, the ability to reliably produce high quality recycled water and the ease of automation.

Figure 10-1 shows a typical process diagram for a membrane bioreactor treatment system. Figure 10-2 demonstrates how MBR facilities can be constructed to blend in with neighborhood architecture. The architectural style in this example would likely be utilized in a rural area. The architectural style employed for this project would have to be consistent with the neighborhood in which the plant is constructed.

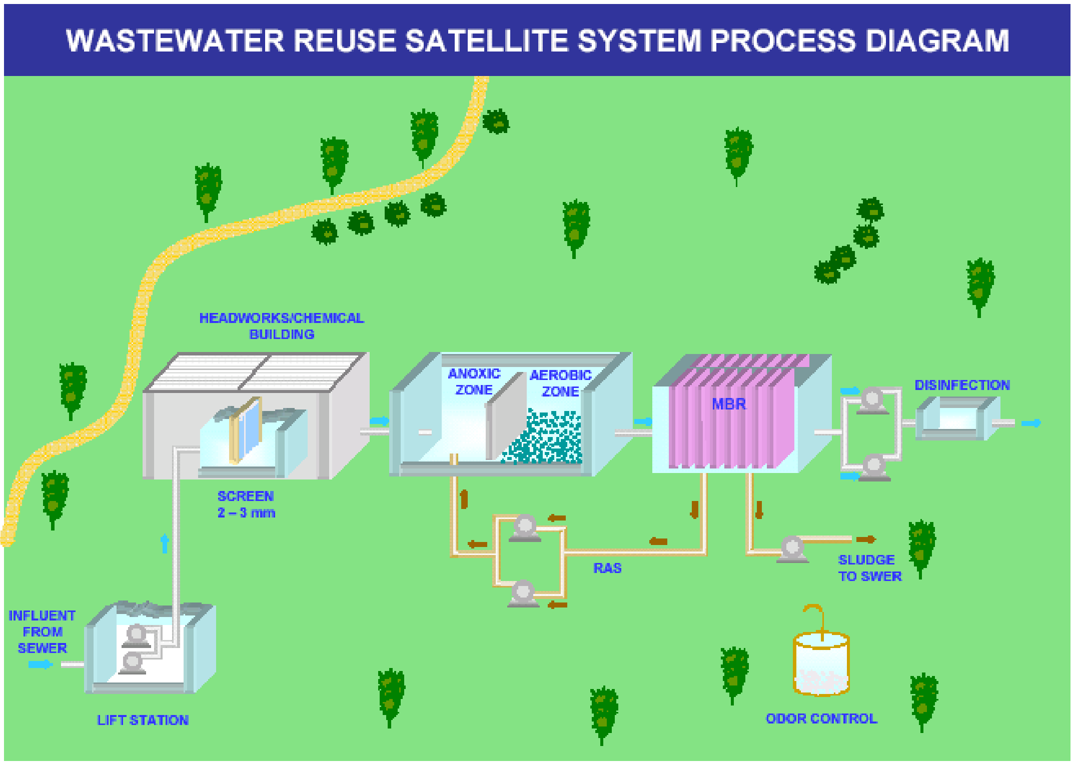


FIGURE 10-1

TYPICAL MBR PROCESS DIAGRAM

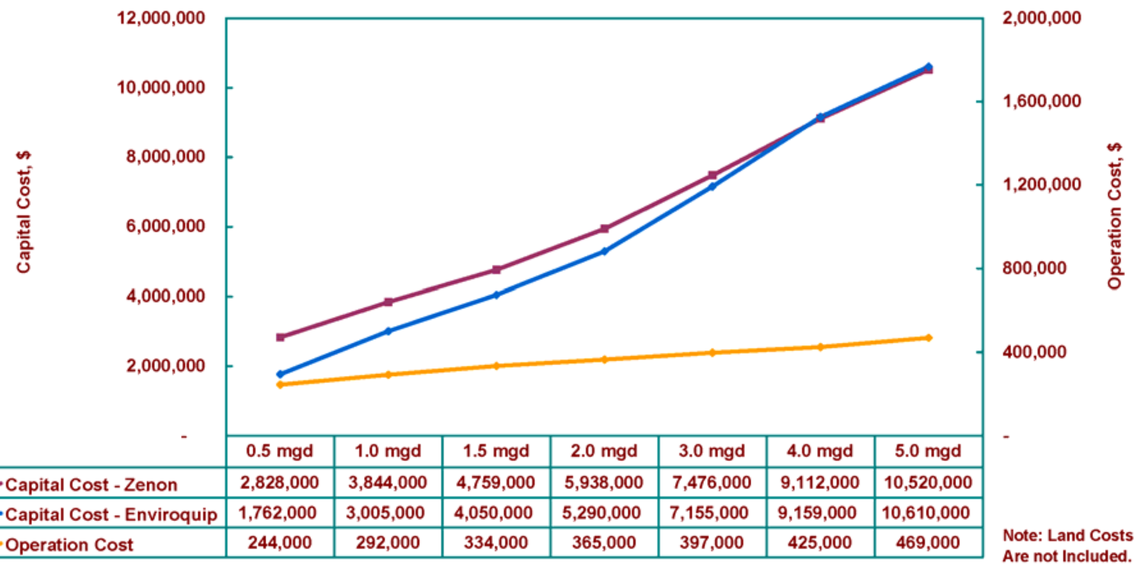
Photo courtesy of Zenon

FIGURE 10-2

EXAMPLE OF MBR FACILITY IN COMMUNITY (DESIGNED TO BLEND IN ARCHITECTURALLY)

(This page intentionally left blank.)

Costs associated with water factories vary with the selected technology and with the manufacturer. Two manufacturers of membrane bioreactor treatment systems (Zenon and Enviroquip) were evaluated, as shown in Figure 10-3.



	0.5 mgd	1.0 mgd	1.5 mgd	2.0 mgd	3.0 mgd	4.0 mgd	5.0 mgd
Capital Cost - Zenon	2,828,000	3,844,000	4,759,000	5,938,000	7,476,000	9,112,000	10,520,000
Capital Cost - Enviroquip	1,762,000	3,005,000	4,050,000	5,290,000	7,155,000	9,159,000	10,610,000
Operation Cost	244,000	292,000	334,000	365,000	397,000	425,000	469,000

FIGURE 10-3
COST CURVES FOR MBRS WITH STORAGE

10.2.3 Advantages and Disadvantages of Water Factories

The use of satellite water factories for providing recycled water to service areas can provide several advantages:

- The construction of water factories in near proximity to end-users eliminates the need to construct long pipelines through fully built-out/developed commercial, residential, and business areas.
- The high quality effluent from MBR plants does not require as much chlorine to maintain residual in distribution system, so there is less chemical storage and usage.
- Shorter pipelines eliminate the need for chlorine booster stations.
- Shorter pipelines reduce costs associated with pumping.
- Water factories can be constructed in stages, allowing implementation of initial recycled water projects with lower initial capital costs.
- Water factories can be automated and run via SCADA by personnel located at other plants.
- Shorter pipelines significantly reduce pipeline flushing costs.

Disadvantages of water factories may include:

- There are significant public relations issues associated with locating a wastewater treatment plant in a residential or otherwise developed area.
- There are capital costs associated with new facilities that are not required for existing facilities.
- There are additional O&M costs associated with operating satellite plants.

Water factories can provide a cost-effective method of strategically developing recycled water sources, particularly in areas far from regional WWTPs.

10.3 Opinion of Probable Construction Costs

The suggested projects within each service area, as described in Chapter 6, were evaluated to determine the cost-effectiveness of the various elements of the proposed recycled water system. Project costs included new facilities and infrastructure, including treatment as required (water factories), pumping facilities, pipelines and storage; operating and maintenance costs; and energy costs.

The annualized capital expenditure and annual operating costs for the development of each recycled water service area were determined, and an annualized cost per 1,000 gallons of recycled water was calculated.

10.3.1 Capital Costs

Capital Costs for the suggested projects in each service area were determined for each phase and then totaled for each service area. Table 10-1 lists capital costs for each service area project. The unit capital cost ($/1000 gallons) for each project is also listed in the table.

In service areas that include a water factory, the capital expenditure for the water factory was included in Phase I. This expenditure results in a higher unit cost for Phase I. The feasibility of developing a given service area is best considered with full development of the service area.

TABLE 10-1
CAPITAL COSTS OF IDENTIFIED PROJECTS
(2005 Dollars)

	Project	Projected Average Supply (MGD)	Capital Costs Total ($10^6)	Capital Costs Unit ($/1000G)
Cedar Crest Pipeline				
1	Extend pipeline to Zoo, Rock-Tenn Area	1.75	$ 6.50	$0.66
2	Phase 2 to Steven Golf Course	0.50	$ 4.16	$1.48
	Total Service Area	2.25	$10.66	$0.84
Lower White Rock Water Factory				
1	Water Factory & PL to Arboretum	0.80	$ 18.62[1]	$4.15[1]
2	PL to Samuel Grand/Tenison	0.60	$ 2.60	$0.77
3	PL to Fair Park	0.75	$ 1.43	$0.34
4	PL to Lakewood Country Club	0.35	$ 0.65	$0.33
	Total Service Area	2.50	$ 23.30	$1.66
Upper White Rock Water Factory				
1	Water Factory & PL to Texas Instruments	5.35	$ 32.40[1]	$1.08[1]
2	PL to Fair Oaks	0.60	$ 1.82	$0.48
3	PL to Medical City	0.10	$ 1.82	$3.24
4	PL to Park Central	0.05	$ 1.17	$4.17
5	PL to The Village	1.40	$ 2.99	$0.38
	Total Service Area	7.50	$ 40.20	$0.96
White Rock Pipeline Alternative		16.50	$ 55.20	$0.60
Love Field / Medical Complex Water Factory				
1	Water Factory & PL to Medical Complex	1.10	$ 16.55[1]	$2.68[1]
2	PL to Brook Hollow Country Club	0.78	$ 2.86	$0.66
3	PL to DART	0.23	$ 1.82	$1.44
4	PL to Love Field	0.15	$ 0.91	$1.08
	Total Service Area	2.25	$ 22.14	$1.75
Southwest Dallas Water Factory				
1	Water Factory & PL to Dallas Golf	0.70	$ 12.87[1]	$3.28[1]
2	PL to Extex Laporte	0.20	$ 1.56	$1.39
3	PL to Dallas Baptist University	0.10	$ 2.08	$3.71
	Total Service Area	1.00	$ 16.51	$2.94
Total System		22.00	$104.51	$0.85

[1]Cost includes water factory and Phase I pipeline.

10.3.2 Operating, Maintenance, and Energy Costs

Operation and Maintenance (O&M) costs, excluding energy costs, were developed based on a typical percentage of capital costs. For this project, the annual O&M cost is estimated to be 2.5 percent of total capital costs for each phase of the project. The 2.5 percent is the standard value used in the Region C Plan and the DWU Long Range Water Supply Plan.

Energy costs were calculated based on pumping power requirements. Horsepower requirements were developed utilizing system flow rates and estimated pumping head. The resulting energy cost is based on $0.06 per KWH.

Table 10-2 lists O&M and energy costs for each service area project. These costs are shown as annual costs and unit costs for each project.

TABLE 10-2
O&M AND ENERGY COSTS OF IDENTIFIED PROJECTS
(2005 Dollars)

	Project	Projected Average Supply	O&M Costs		Energy Costs	
		(MGD)	Annual	($/1000G)	Annual	($/1000G)
Cedar Crest Pipeline						
1	Extend pipeline to Zoo, Rock-Tenn Area	1.75	$ 162,500	$0.25	$ 60,168	$0.09
2	Phase 2 to Steven Golf Course	0.50	$ 104,000	$0.57	$ 17,191	$0.09
	Total Service Area	2.25	$ 266,500	$0.32	$ 77,359	$0.09
Lower White Rock Water Factory						
1	Water Factory and PL to Arboretum	0.80	$ 465,563	$1.59	$ 33,006	$0.11
2	PL to Samuel Grand/Tenison	0.60	$ 65,000	$0.30	$ 24,755	$0.11
3	PL to Fair Park	0.75	$ 35,750	$0.13	$ 30,943	$0.11
4	PL to Lakewood Country Club	0.35	$ 16,250	$0.13	$ 14,440	$0.11
	Total Service Area	2.50	$ 582,563	$0.64	$ 103,145	$0.11
Upper White Rock Water Factory						
1	Water Factory and PL to Texas Instruments	5.35	$ 809,900	$0.41	$ 294,307	$0.15
2	PL to Fair Oaks	0.60	$ 45,500	$0.21	$ 33,006	$0.15
3	PL to Medical City	0.10	$ 45,500	$1.25	$ 5,501	$0.15
4	PL to Park Central	0.05	$ 29,250	$1.60	$ 2,751	$0.15
5	PL to The Village	1.40	$ 74,750	$0.15	$ 77,015	$0.15
	Total Service Area	7.50	$1,004,900	$0.37	$ 412,579	$0.15
White Rock Pipeline Alternate		16.50	$1,380,000	$0.23	$ 825,159	$0.14
Love Field/Medical Complex Water Factory						
1	Water Factory and PL to Medical Complex	1.10	$ 413,758	$1.03	$ 37,820	$0.09
2	PL to Brook Hollow Country Club	0.78	$ 71,500	$0.25	$ 26,646	$0.09
3	PL to DART	0.23	$ 45,500	$0.55	$ 7,736	$0.09
4	PL to Love Field	0.15	$ 22,750	$0.42	$ 5,157	$0.09
	Total Service Area	2.25	$ 553,508	$0.67	$ 77,359	$0.09
Southwest Dallas Water Factory						
1	Water Factory PL to Dallas Golf	0.70	$ 321,848	$1.26	$ 31,287	$0.12
2	PL to Extex Laporte	0.20	$ 39,000	$0.53	$ 8,939	$0.12
3	PL to Dallas Baptist University	0.10	$ 52,000	$1.42	$ 4,470	$0.12
	Total Service Area	1.00	$ 412,848	$1.13	$ 44,696	$0.12
Total System		22.00	$2,612,856	$0.33	$1,024,572	$0.13

10.3.3 Service Areas Evaluation Including Costs

The total cost of supplying recycled water for each of the identified projects was calculated, including:

- Annual debt service during the capital recovery period
- Annual O&M costs during the project life
- Annual energy costs during the project life

These are expressed in dollars per 1000 gallons for each project in Table 10-3. Unit rates are shown for the capital recovery period (first 30 years) and the average for the project life (50 years).

TABLE 10-3
TOTAL UNIT RECYCLED WATER COST FOR IDENTIFIED PROJECTS
(2005 Dollars)

	Project	Projected Average Supply	30 Year Water Cost Present Value	50 Year Water Cost Present Value
		(MGD)	($/1000G)	($/1000G)
Cedar Crest Pipeline				
1	Extend pipeline to Zoo, Rock-Tenn Area	1.75	$1.01	$0.75
2	Phase 2 to Steven Golf Course	0.50	$2.15	$1.55
	Total Service Area	2.25	$1.26	$0.93
Lower White Rock Water Factory				
1	Water Factory & PL to Arboretum	0.80	$5.86	$4.20
2	PL to Samuel Grand/Tenison	0.60	$1.18	$0.87
3	PL to Fair Park	0.75	$0.58	$0.45
4	PL to Lakewood Country Club	0.35	$0.57	$0.44
	Total Service Area	2.50	$2.41	$1.75
Upper White Rock Water Factory				
1	Water Factory & PL to Texas Instruments	5.35	$1.64	$1.21
2	PL to Fair Oaks	0.60	$0.84	$0.65
3	PL to Medical City	0.10	$4.64	$3.34
4	PL to Park Central	0.05	$5.92	$4.26
5	PL to The Village	1.40	$0.68	$0.53
	Total Service Area	7.50	$1.47	$1.09
White Rock Pipeline Alternate		16.50	$0.96	$0.72
Love Field/Medical Complex Water Factory				
1	Water Factory & PL to Medical Complex	1.10	$3.81	$2.73
2	PL to Brook Hollow Country Club	0.78	$1.00	$0.74
3	PL to DART	0.23	$2.09	$1.51
4	PL to Love Field	0.15	$1.59	$1.16
	Total Service Area	2.25	$2.52	$1.82
Southwest Dallas Water Factory				
1	Water Factory & PL to Dallas Golf	0.70	$4.66	$3.35
2	PL to Extex Laporte	0.20	$2.05	$1.49
3	PL to Dallas Baptist University	0.10	$5.25	$3.77
	Total Service Area	1.00	$4.20	$3.02
Total System		22.00	$1.30	$0.96

Based on the analysis, the Cedar Crest Corridor Service Area has the lowest unit cost. This finding is not surprising, since a portion of this service area is presently under development. In addition, since the recycled water is produced at the Central WWTP, a water factory and storage tank is not required.

The service area with the second-lowest unit cost is the Upper White Rock Service Area. This is primarily due to the potential recycled water demand of Texas Instruments (TI). The three projects within the Upper White Rock Service Area that appear to be economical are the pipeline to TI, the pipeline south to Fair Oaks and the pipeline continuing south to the Village Apartments. The pipelines to Medical City and Park Central Development do not appear to be economical because the anticipated recycled water demand is low.

The service area with the third-lowest unit cost is the Lower White Rock Service Area. This service area has significant potential, primarily because it contains mostly City-owned facilities. The Arboretum is a natural showplace for demonstrating recycled water usage. Samuel Grand Park, Tenison Park Golf Course and Fair Park are also prime candidates for raising the public awareness of the various uses for recycled water. Tenison Golf Course has a raw water contract for irrigation; however, the raw water usage reported in the metering data was not significant, while potable water usage was high. Finally, Lakewood Country Club was initially considered to be a potential recycled water customer. However, it was reported to the Design Team, that Dallas Water Utilities was entering into discussions with the Park Department regarding a raw water contract for Lakewood Country Club.

The White Rock Pipeline Alternative has a lower unit cost than the combination of the Upper White Rock and Lower White Rock Service Areas. In addition, this alternative has the following added features:

1. No satellite water factories are required in the White Rock Creek basin.

2. Two pump stations; one at Central WWTP and a booster pump station have been included.

3. The pipeline system has been sized to provide 30 MGD of recycled water to IH-635 and 20 MGD to North Dallas, which provides capacity for other potential customers (beyond the projected average supply of 16.5 MGD shown in Table 10-3).

4. Some provisions for maintaining chlorine residual in the pipeline may be required.

The Love Field/Medical Complex Service Area and Southwest Service Area did not prove to be economical. Both areas had relatively low identified recycled water demand and required rather extensive infrastructure improvements to provide recycled water to the areas.

10.4 Benefits of Implementing Recycled Water Projects

10.4.1 General

There are both tangible and intangible benefits associated with implementing recycled water projects that justify or otherwise offset the cost of the projects. Some of the areas impacted include:

- Water Supply, Treatment, and Distribution – Deferring Planned Projects
- Wastewater Collection and Distributions Systems – Deferring Expansion of Plants or Interceptor Capacity
- Intangibles – Water Conservation, Resources Management, and Per Capita Usage

Since recycled water can meet a portion of the water demand that would otherwise be met by the potable water system, the existing and planned potable water infrastructure can meet a larger portion of the water demand that must be provided with potable water. A fully developed recycled water system that provides a significant quantity of water may delay or even avert the need for future potable water system expansion.

10.4.2 Water Supply, Treatment, and Distribution

One of the most significant benefits of using recycled water, in place of some of the new water supplies planned by DWU, is that significant volumes can be brought online quickly at significantly lower cost than many of the new water supply projects. Another advantage is that planned raw water supply projects may be deferred for several years. Deferring expensive water supply projects allows funds that would initially be required for the debt service on the water supply project to be put back into the community.

There are methods of calculating an economic value for the deferral. These methods assume that the monies not paid in debt service during the years of deferring represent a dollar amount that is put back into the community and accrues value at the rate the economy grows. An example of this type of calculation is presented in Appendix G relative to the 3-year delay of the Lake Palestine raw water project. These financial impact benefits are difficult to assess and were not included in the economic analysis; however it is recognized that they do represent a value or benefit of the recycled water projects.

10.4.3 Benefits Related to Wastewater Collection and Treatment Systems

The primary benefits to be realized with recycled water projects relative to wastewater collection and treatment projects are related to the construction of water factories. The two primary economic benefits are listed below.

- Water factories can intercept flows and reduce loads on downstream interceptors, deferring or eliminating the need for parallel lines.
- Water factories, by taking flow off of the existing treatment plant can defer expansion of other wastewater treatment facilities.

Because there were no water factory projects recommended in the initial projects, there is no economic benefit analysis done at this time.

10.4.4 Intangible Benefits

There are also several intangible benefits to implementing recycled water projects, including the following:

- Demonstrates recycled water and water conservation efforts that can play a role in the approval of water rights permits and interbasin transfer (IBT) permits
- Shows progressive water resources management
- Reduces the calculated per capita water usage

10.5 Recycled Water Costs

This project has identified two direct, nonpotable recycled water projects that should be developed further, including:

1. Cedar Crest Pipeline Extension Project, Phases 1 and 2.
2. White Rock Pipeline Alternative Project

Table 10-4 shows the cost of water for the recycled water projects that are proposed for implementation. These costs are near or less than the recommended price for recycled water (see Chapter 14, for our recommendation for pricing of recycled water). These costs do not include any of the raw water project deferral benefits discussed in Section 10.4.2.

TABLE 10-4
TOTAL UNIT COST FOR PROPOSED RECYCLED WATER PROJECTS
(2005 Dollars)

Project	Identified Average Usage	Projected Average Supply	Capital Costs	O&M Costs	Energy Costs	30-Year Water Cost Present Value	50-Year Water Cost Present Value
	(MGD)	(MGD)	($/1000G)	($/1000G)	($/1000G)	($/1000G)	($/1000G)
Cedar Crest Pipeline Extend pipeline to Zoo, Rock-Tenn Area	1.74	1.75	$0.66	$0.25	$0.09	$1.01	$0.75
White Rock Pipeline Alternate	7.37	16.50	$0.60	$0.23	$0.14	$0.96	$0.72
Recommended Recycled Water System	9.11	18.25	$0.60	$0.23	$0.13	$0.97	$0.73

Further, in Table 10-5, the cost of recycled water as an alternative raw water supply project is compared with the anticipated cost of the raw water supply from Lake Palestine. In this comparison, recycled water appears to be a competitive and viable supply of raw water.

TABLE 10-5
RECYCLED WATER COMPARED TO LAKE PALESTINE AS A RAW WATER SUPPLY

Project	System Capacity	Projected Average Supply	Projected Annual Supply	Capital Costs		Energy Costs		O&M Costs		Projected Average Supply (30-year)	Projected Average Supply (50-year)
	(MGD)	(MGD)	(Acre-Ft)	Annual	($/1000G)	Annual	($/1000G)	Annual	($/1000G)	($/1000G)	($/1000G)
Lake Palestine Projects	120.00	102.00	114,254	$422,600,000	$0.87	$7,607,964	$0.24	$10,565,000	$0.33	$1.44	$1.10
Total Recycled Water System	43.50	22.00	24,643	$104,510,000	$0.85	$1,024,572	$0.13	$2,612,856	$0.33	$1.30	$0.96
Recommended Recycled Water System	33.50	18.25	20,442	$61,700,000	$0.60	$885,327	$0.13	$1,542,500	$0.23	$0.97	$0.73

This page intentionally left blank.)

CHAPTER 11

RECYCLED WATER PROGRAM
ORGANIZATIONAL STRUCTURE

11.1 Introduction

This chapter addresses options for fitting the functions necessary for successful operation of a Recycled Water Program into the Dallas Water Utilities' (DWU's) organizational structure. Accomplishing this goal is a little like trying to fit a square peg into a round hole for by its very nature, a Recycled Water Program is a hybrid, crossing the boundaries of both water supply and wastewater divisions. Further, other cities have found that as their recycled water programs grow and mature, there is a need to revise the organizational structure, adding some new components as well as moving others.

The first section of this chapter will review some of the experiences of two cities with active and growing recycled water programs – the cities of St. Petersburg, Florida, and San Antonio, Texas. Next, the basic functional components necessary for a successful recycled water program are identified along with options of where these might be included in the DWU organizational structure. Finally, recommendations are made regarding structuring of the recycled water program functions for the initial implementation phase of DWU's program with full recognition that as the program matures and grows, these functions may be moved and/or changed.

11.2 Example Organizational Structures

The organizational structure for a recycled water program varies from program to program since the structure is generally coordinated with and supported by other components of a utilities operation. The approaches to organizational structures for the City of St. Petersburg and San Antonio Water System (SAWS) are described below:

St. Petersburg, Florida

The St. Petersburg Recycled Water Program began as an alternative to discharging treated effluent into the environmentally sensitive Everglades area. From its inception, the program included supplying reclaimed water for both industrial and residential use. The program has been well received and has evolved to include the following administrative and field operations structure.

Administration:

- Recycled Water Program Manager
- Public Information/Program Analyst
- Engineering Clerk
- Marketing and Public Relations Person
- Engineering Design and Technical Assistance Person

- Clerical Personnel
- Customer Service Personnel

Field Services:

- Service Supervisor (1)
- Service Foreman (1)
- Inspectors (3)
- Service Technician (3)
- Service Apprentices (2)

Additionally, interdepartmental support is provided by the City's Legal Department for document services and execution and from the Finance Department for funding and billing activities. A primary focus of the administrative team is to develop policies and procedures required for the orderly development and operations of the recycled water program, identifying and initiating code modifications, developing monitoring protocols, developing marketing strategies, and developing health and safety training programs for treatment operations, field service, and administrative personnel. Field service operations include tasks associated with distribution and user sites, routine functions and site evaluations, customer interaction providing specific information about water quality, treatment processes, and the user application process. Field functions also include site inspection and enforcement.

San Antonio Water Systems (SAWS)

The SAWS Recycled Water Program organizational structure has and continues to evolve. The initial structure involved integrating the various Recycled Water Program activities into existing organization functions. For example, the treatment group provides treatment and maintains and operates the tanks, pumps, and piping within the boundaries of the treatment plant. Outside the plant boundaries the operations group and the production group maintains and operates tanks, pumps, and piping for delivery of the recycled water to the customers. Other aspects of the Recycled Water Program are performed by other groups (i.e., laboratory, etc.). Consideration has been given to establishing a separate utility; however, SAWS has not taken that step to date. The responsibility for the SAWS reclaimed water program has recently been placed under the treatment group. Currently, two to three people are specifically designated for the SAWS Reclaimed Water Program. Two of these people are specifically involved in marketing of the reclaimed water. Other personnel that are assigned to different groups have responsibilities in addition to the services that they provide for the Reclaimed Water Program.

11.3 Options For DWU's Recycled Water Program Structure

A DWU Recycled Water Program would involve several functional components including business activities (i.e., customer contracts, billing, etc.); public interface activities (i.e., public information, public relations, etc.); marketing activities; wastewater treatment activities; and recycled water transportation and distribution activities. A key consideration relative to a DWU Recycled Water Program is establishing an organizational structure. The Recycled Water Program could be achieved through creating one of the following:

- An independent DWU Recycled Operations Group with its own staff and interdepartmental support, parallel in function to both water and wastewater operations.

- A Recycled Water Operations Group within the existing DWU Water Operations or Wastewater Operations, with staff additions, and interdepartmental support. This option places the functions related to the recycled water program exclusively under either the Water Operations or Wastewater Operations group.

- An Operation with a Manager that is supported by the DWU Water Operations and Wastewater Operations, with staff additions, and interdepartmental support. This option includes dividing the responsibilities of the recycled water program operations into the existing operations groups most closely related in function to the new activities (e.g., distribution of recycled water within the existing water distribution group or production of recycled water within the existing wastewater treatment group).

There are advantages and disadvantages of each approach. The next section of this chapter discusses the options and the issues associated with each.

11.3.1 Independent DWU Operations

The Recycled Water Program will require personnel to carry out administrative and technical responsibilities. As the Recycled Water Program matures, the staff positions to perform these responsibilities could include:

Administration:

- Recycled Water Program Manager
- Recycled Water Program Marketing/Sales Person
- Public Information/Public Relations Person
- Recycled Water Program Engineer
- Recycled Water Program Technical Assistant
- Engineering

Field Services:

- Supervisor
- Foreman
- Inspectors
- Service Technician

Additionally, interdepartmental support from Legal, Finance, and Code Enforcement will be required.

The need for and cost that would be incurred to establish an independent operation do not support the initial establishment of an independent operation. As the Recycled Water Program matures and a significant recycled water customer base is established, consideration should be given to the establishment of an independent operation.

11.3.2 Operations Within DWU Water or Wastewater Operations

In assessing whether a Recycled Water Program should be established within the Water or Wastewater Operations, consideration should be given to not only the experience and resources to perform the various functions but also to resulting benefits that may be relative to each Operation. Perspectives about placing it under Water or Wastewater are presented below.

Incorporating the Recycled Water Program into the DWU Water Operations involves several considerations. First of all, the Recycled Water Program could provide a number of benefits to the DWU Water Operations. For example, the use of recycled water could contribute to deferring the need for new raw water and extend the life of the existing potable water treatment plants and potable water distribution system. Additionally, the use of the recycled water could contribute to the City's objectives to reduce the per capita consumption of its customers. The achievement of these benefits could potentially justify the commitment of funds from the water operations to help with funding the initial stages of the recycled water program. If funding were provided, the source of the funds would be Dallas as well as its wholesale customers. Another positive perspective relative to being part of the DWU Water Operations involves benefiting from the reputation of DWU in providing a safe dependable supply of potable water that would be extended to providing the recycled water. The experience of the DWU water operations with pressurized water delivery systems and other operational aspects (i.e., avoidance of cross-connections, backflow prevention, maintaining water quality, etc.) are also important considerations. On the other hand, the DWU Water Operation is not experienced with operating wastewater treatment plants. Also, the wholesale water customers would need to be educated about the recycled water program to gain their understanding and support for providing funding support in order to gain the benefits. The Wholesale Water Customers' contracts may need to be amended to facilitate gaining this funding support.

Incorporating the Recycled Water Program into the DWU Wastewater Operations also involves several considerations. Of utmost importance is that the wastewater operations would be responsible for producing a dependable high quality product. The Wastewater Operations is experienced at achieving this objective and complying with associated regulatory requirements. On the other hand, DWU Wastewater Operations is not experienced with dealing with water supply customers, operating pressurized water delivery systems, or collecting and justifying rates for water sales.

11.3.3 Operations with a Recycled Water Program Manager

The initial establishment of a Recycled Water Program with a designated manager, limited administrative staff, functional support from Water Operations and Wastewater Operations, and interdepartmental support could benefit from the advantages discussed above under the DWU Water and Wastewater Operations. This approach would maximize the benefits of the experience associated with each of these operations and would minimize the initial costs to establish a Recycled Water Program. In addition, it could serve as the initial phase of an independent Operations to be established as the Recycled Water Program matures.

11.4 Recommended Recycled Water Program Organization

To successfully implement the DWU Recycled Water Program, the organizational structure selected should seek to facilitate meeting the following objectives:

- Perform management duties and provide leadership to promote the Recycled Water Program to maximize its benefit as a water management strategy.
- Develop required policies and procedures.
- Perform treatment required to provide a high quality recycled water to meet the customers' needs and to be compliant with regulations.
- Perform operations and maintenance required to deliver recycled water to customers.
- Perform laboratory testing and reporting.
- Perform business and legal-related activities.
- Perform actions necessary to protect the safety of the potable water system.

Based on the various considerations of each of the options and the experience of other entities, it is recommended that DWU establish an organizational structure with a designated manager that is supported by DWU Water and DWU Wastewater Operations as well as interdepartmental support (See Figure 11-1.). It is recommended that limited staffing be established in the initial period of startup with plans to add additional staff members on a continuing basis, as the recycled water customer base grows, during the first five years of operation.

It is recommended that the initial staffing functions be provided as follows:

1) Recycled Water Program Manager position established under Water Operations.

2) Marketing assumed by wholesale services.

3) Public information/public relations assumed by the DWU Water Conservation Function.

4) Production of recycled water continues under DWU Wastewater Operation.

5) Recycled Water Delivery assumed by DWU Water Operations (i.e., pumping and distribution).

6) Backflow and cross-connection management assumed by Dallas Plumbing.

7) Management of the development of required O&M manual, policies and procedures, and technical specifications assumed by Recycled Water Program Manager in coordination with DWU Water Operations and Dallas Wastewater Operations.

8) Management of the design and construction of recycled water delivery system tanks, pumps, and pipelines assumed by Pipeline Project Management.

9) Management of the design and construction of wastewater treatment plant improvements and/or water factories assumed by Wastewater Facilities Project Management.

10) Laboratory testing assumed by Pretreatment and Laboratory Services.

(This page was intentionally left blank.)

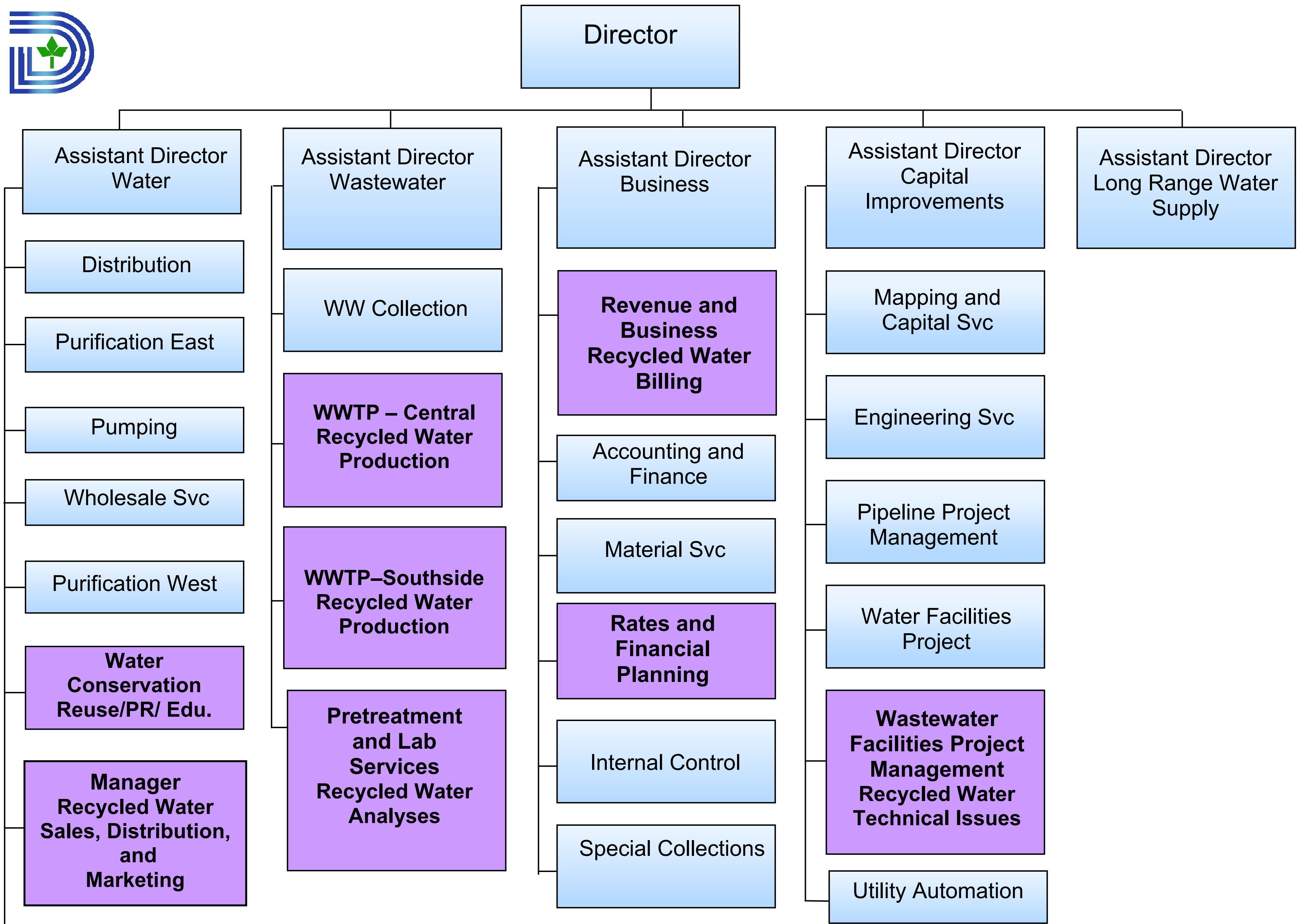


FIGURE 11-1
DALLAS WATER UTILITIES
PROPOSED RECYCLED WATER OPERATIONS STRUCTURE

(This page intentionally left blank.)

11) Recycled Water customer rates and billing assumed by DWU Rates and Finance Planning.

The level of effort required for each of the proposed staffing functions will be dependent upon the interest expressed by potential recycled water customers and demands on the DWU staff. The preliminary levels of effort presented in Table 11-1 represent an opinion of probable staffing needs for the initial year of a Recycled Water Program.

TABLE 11-1
RECYCLED WATER PROGRAM
ESTIMATED PERSONNEL EFFORTS

Function	Probable Effort (hours)
Manager	2,080
Marketing	2,080
Public Information/Public Relations	1,040
Wastewater Treatment	260
Recycled Water Delivery	260
Backflow/Cross-Connection Control	260
O&M Manuals, Policies and Procedures	1,040
Recycled Water Delivery System Design	1,040
Wastewater Treatment Facilities Design	1,040
Laboratory Testing	1,040
Customer Rates and Billing	1,040
Total	11,180

11.5 Policies and Procedures

Regardless of the organizational structure selected, the Recycled Water Program will also require the development and implementation of a number of Policies and Procedures. The following presents a number of considerations that must be covered by the policies and procedures.

- Infrastructure technical design specifications
- Cross-connection control requirements
- Site inspection authority
- Enforcement policies
- Recycled Water Program operation and maintenance manual
- Recycled Water User manual
- Emergency Response Plan

The development of these recycled water program policies and procedures should be coordinated with existing City of Dallas policies and procedures.

11.6 Summary

Implementing a Recycled Water Program represents a new dimension for cities used to providing water and/or treating wastewater. By crossing the boundaries of both functions, recycled water programs are often difficult to fit into the existing organizational structures of cities. A variety of approaches have been tried and implemented successfully. For initial implementation in Dallas, it is recommended that the City establish a Recycled Water Program Manager with support in both the Water Operations and Wastewater Operations Divisions. It should be recognized that, as the Dallas Recycled Water Program grows and matures, restructuring of the functions of the program might become necessary. In addition to establishing a management and operations structure, numerous policies and procedures will need to be established.

CHAPTER 12

REGULATIONS, POLICIES, AND RECYCLED WATER PRICING

12.1 Introduction

There are a number of regulations that need to be considered during the establishment and implementation of a DWU Recycled Water Program. The regulations involve City of Dallas ordinances and policies as well as the Texas Water Code. The following identifies ordinances and policies and state of Texas rules pertinent to a Recycled Water Program. Discussions are presented regarding suggested changes to update certain ordinances and policies. Additionally, information is presented regarding procedures to comply with the Texas Water Code rules.

12.2 Reclaimed Water Use Notification

The current state law allows the use of recycled water for application from a wastewater treatment plant directly to the point of use unless it is prohibited in the underlying water rights permit. The Texas Water Code Title 30, TAC, Chapter 210 includes the provisions covering the direct reuse of recycled water. Gaining TCEQ approval for direct use of recycled water involves submittal of information regarding the proposed system and use applications in the form of a Reclaimed Water Use Notification.

In February 2004, DWU submitted a Reclaimed Water Use Notification for the Cedar Crest Golf Course recycled water project to TCEQ. DWU received approval of this project. The approval was for Type II recycled water uses as defined in Table 4-3.

An additional Reclaimed Water Use Notification will need to be submitted to TCEQ to cover projects to be implemented by the DWU Recycled Water Program. The major potential uses of recycled water identified by this study can be achieved with Type II water. However, committing to the more stringent Type I water quality provides the opportunity to serve additional customers. Based on the analysis performed by this project, it appears that the treatment plants have the ability to produce a Type I water. However, the consistent production of Type I water may require some minor plant improvements and operational procedure modifications. It is recommended that DWU plant operating personnel consider the achievement of Type I water on a consistent basis. If this assessment concludes that Type I water can be achieved, the Reclaimed Water Notification submitted to TCEQ should reflect that quality of water.

12.3 Recycled Water Pricing

The pricing of recycled water is currently established by Dallas City Code Chapter 49, Section 18.5, which includes the following statement: “Wastewater treatment plant effluent may be purchased for one-half of the regular rate for untreated (raw) water.”

The existing city code sets the price of recycled water far below that typically associated with recycled water. The project reviewed the pricing of recycled water by other cities and found that it was typically priced at 75 to 80 percent of potable water rates. Further, many cities restrict the supply of city-supplied raw water to customers and offer recycled water instead.

It is recommended that Dallas consider updating the city code to make recycled water a valuable resource that is in high demand by including the following:

- Setting the recycled water rate at 75 to 80 percent of the potable water rate, and

- Consider restricting the sales of raw water within the target recycled service areas and contesting term water rights permits.

- Modify the language of the Code to allow the City to finance recycled water distribution projects as water supply alternatives.

By implementing these recommendations, recycled water projects would be more viable and the need for new water sources will likely be deferred.

12.4 Recycled Water Customer Contract

A standard contract to be executed with recycled water customers needs to be developed and adopted. The contract must include provisions necessary to address the following issues as well as other considerations typically included in DWU water customer contracts.

- Delineation of DWU's and customer's responsibilities
- Intended uses and description of areas of application of recycled water
- Uses prohibited
- Quantities of recycled water
- Price of recycled water
- Compliance with City rules, regulations, policies, and procedures
- Compliance with TCEQ rules and regulations
- Right for DWU to review and comment on customers' recycled water systems
- Right for DWU and plumbing inspection
- Enforcement provisions
- Facilities construction
- Delivery of recycled water
- Quantity and unit measurement
- Quality to be provided
- Pressure requirements
- Payments by purchaser
- Suspension of service
- Obligation of the parties
- Remedies upon default
- Procedures for contract amendment

Of major importance is that the contract includes provisions that protect the potable water system from cross-connection with the recycled water. An example contract document is included in Appendix F for use in developing a standard DWU contract for recycled water projects. It should <u>not</u> be considered a finished contract ready for use.

12.5 Zoning Considerations

This project has identified facilities that would be included in various recycled water systems. The systems could involve recycled water storage tanks, pump stations, satellite water factories, and pipelines. The specific location of system facilities will be determined during the preliminary design phases. It is important that the current zoning of areas considered for locating these facilities be identified. In some cases, zoning adjustments may be required and/or a Special Use Permit may be required.

12.6 Financing of Recycled Water Projects

Dallas City Code Chapter 49, Section 18.5 states "No [recycled water] distribution facilities will be provided by the city." The City should consider updating the City Code to allow DWU to finance recycled water projects, including distribution facilities, as alternative water supply projects.

The project identified some other funding options available to finance recycled water projects including:

- TWDB financing, state participation funding of excess capacity for future expansion (up to 50 percent).

- Potable water customer contributions in a similar manner to financing raw water supply projects.

- Federal grants

- The recycled water customer may be required to fund delivery system components in a manner that is consistent with the City's program to provide service to a new subdivision.

12.7 Recycled Water Program Policies and Provisions

The Recycled Water Program will require the development and implementation of a number of policies and procedures. The following presents a number of considerations that should be covered by the policies and procedures.

- Infrastructure technical design specifications
- Cross-connection control requirements
- Site inspection authority
- Enforcement policies
- Recycled water program operation and maintenance manual
- Recycled water user manual
- Emergency Response Plan

The development of these water recycled program policies and procedures should be coordinated with existing DWU policies and procedures. It would be prudent to have these policies in place prior to moving forward with construction of additional recycled water projects. By doing so, quality control can be imposed on the projects to protect public health and ensure quality recycled water projects.

(This page intentionally left blank.)

CHAPTER 13

RECOMMENDED IMPLEMENTATION PLAN

13.1 Introduction

The primary objectives of this project are to further develop the DWU Recycled Water Program and develop an implementation plan for one or more viable recycled water projects. The advancement of the DWU Recycled Water Program will involve the development of a number of policies and procedures as well as modification of some existing City ordinances. The development of the Program will also build upon the experience of the Cedar Crest Golf Course recycled water pilot project, which is in the early start-up stages. Additionally, an organizational structure will need to be established to provide the leadership, marketing, and operations infrastructure necessary for a successful project. Also, there are actions that need to be taken to comply with state of Texas regulations.

The plan has identified viable Type II, non-potable recycled water projects that may be pursued for implementation. In addition, the plan has developed information that supports the value of performing a more extensive investigation of using recycled water to augment the DWU potable water supply. The project developed information that was incorporated into the Five-Year Strategic Plan for Water Conservation.

13.2 Implementation Plan

This section discusses the various actions and proposed schedule for further developing a DWU Recycled Water Program and pursuing the implementation of recommended viable recycled water projects. The next steps are outlined in Table 13-1 and a proposed timeline is presented in Figure 13-1.

13.2.1 Administrative Actions

The following are recommended administrative actions that are fundamental to the recycled water program. It would be beneficial to implement these actions early in the program.

Recycled Water Program Organization

In order to implement a recycled water program, DWU will establish a program organization with a designated manager, limited administrative staff, functional support from Water Operations and Wastewater Operations (see Figure 13-2), and interdepartmental support. This approach will maximize the benefits of the experience associated with the existing water/wastewater operations and will minimize the initial costs of establishing a recycled water program.

DWU will identify and/or employ a program manager and a marketing person whose full-time responsibility is implementation of the Recycled Water Program at the appropriate time as the program progresses. The initial focus of these staff members will be on establishing the required policies and procedures (see Sections 12.4 and 12.7), developing and implementing the public

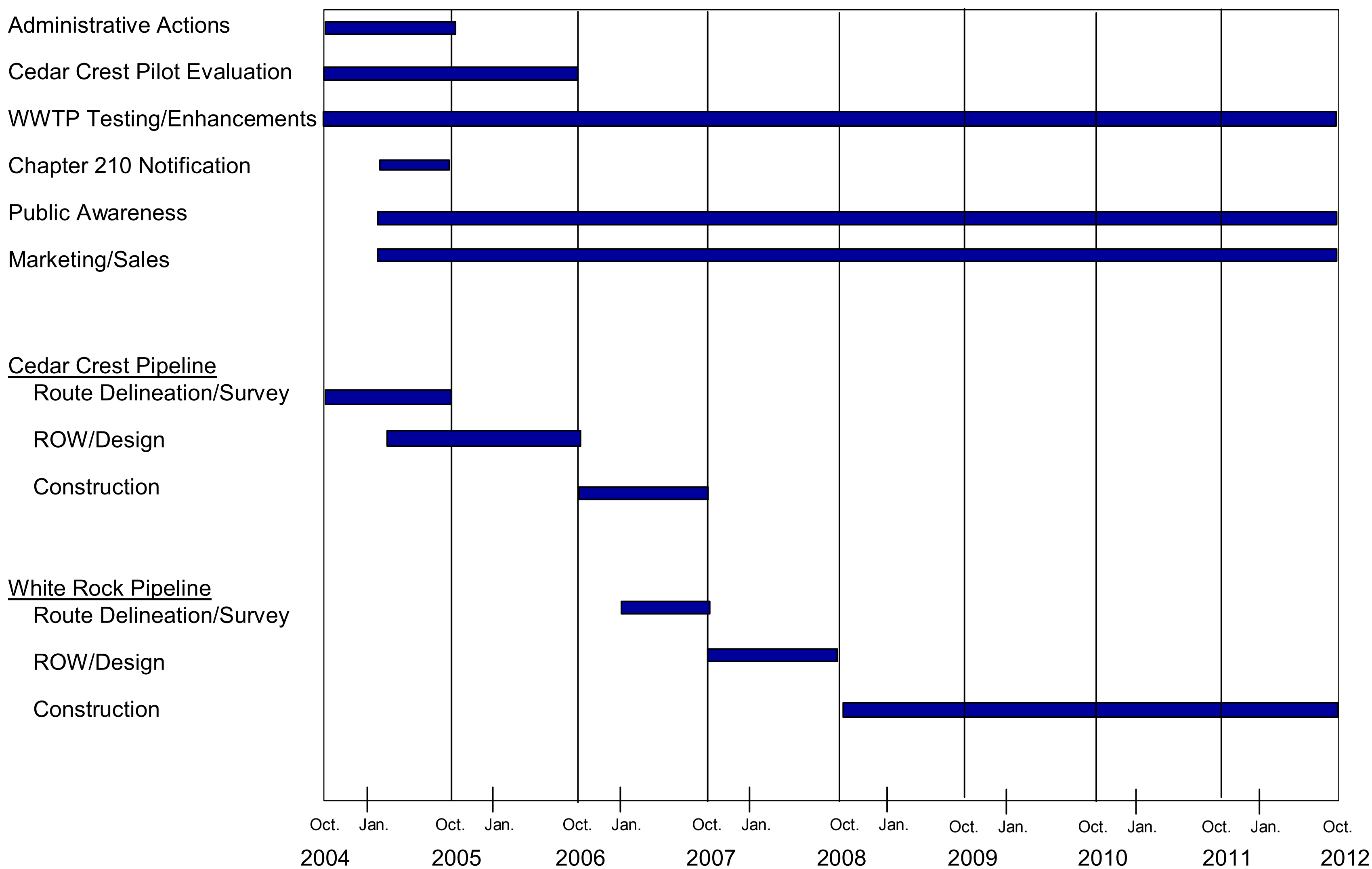
(This page intentionally left blank.)

TABLE 13-1
DALLAS WATER UTILITIES
RECYCLED WATER IMPLEMENTATION PLAN

FISCAL YEAR 2004 (not shown in Figure 13-1)
☐ Develop Recycled Water Implementation Plan. ☐ Monitor and evaluate operation of Cedar Crest golf course pilot recycled water project. ☐ Continue wastewater treatment plant testing of additional parameters.
FISCAL YEAR 2005
☐ Perform Administrative Actions o Initiate actions to establish recycled water organizational structure. o Develop and adopt policies and procedures. o Update City ordinances (i.e., rates, financial provisions. o Develop and adopt recycled water standard contract. ☐ Perform Cedar Crest Pilot Evaluation. ☐ Continue wastewater treatment plant testing of additional parameters. Based on monitoring results, initiate operations enhancement program, if necessary. ☐ Revise Chapter 210 Notification. ☐ Initiate Public and Water Customer Recycled Water Awareness Program. ☐ Initiate recycled water marketing and sales activities. ☐ Finalize routing delineation and surveying for Cedar Crest pipeline extension. ☐ Begin right-of-way acquisition and design for Cedar Crest pipeline extension.
FISCAL YEAR 2006
☐ Perform Cedar Crest Pilot Evaluation. ☐ Continue wastewater treatment plant testing of additional parameters. ☐ Continue Public and Water Customer Recycled Water Awareness Program. ☐ Continue recycled water marketing and sales activities. ☐ Continue design for Cedar Crest pipeline extension.
FISCAL YEAR 2007
☐ Continue wastewater treatment plant testing of additional parameters. ☐ Continue Public and Water Customer Recycled Water Awareness Program. ☐ Continue recycled water marketing and sales activities. ☐ Construct Cedar Crest pipeline extension. ☐ Perform routing delineation and surveying for White Rock Creek corridor pipeline.
FISCAL YEAR 2008
☐ Continue wastewater treatment plant testing of additional parameters. ☐ Continue Public and Water Customer Recycled Water Awareness Program. ☐ Continue recycled water marketing and sales activities. ☐ Perform right-of-way acquisition and design for White Rock Creek corridor pipeline.
FISCAL YEARS 2009-2012
☐ Continue wastewater treatment plant testing of additional parameters. ☐ Continue Public and Water Customer Recycled Water Awareness Program. ☐ Continue recycled water marketing and sales activities. ☐ Initiate and complete phased construction of White Rock Creek corridor pipeline.

(This page was intentionally left blank.)

Figure 13-1
Dallas Water Utilities
Recycled Water Implementation Plan
Proposed Schedule



(This page was intentionally left blank.)

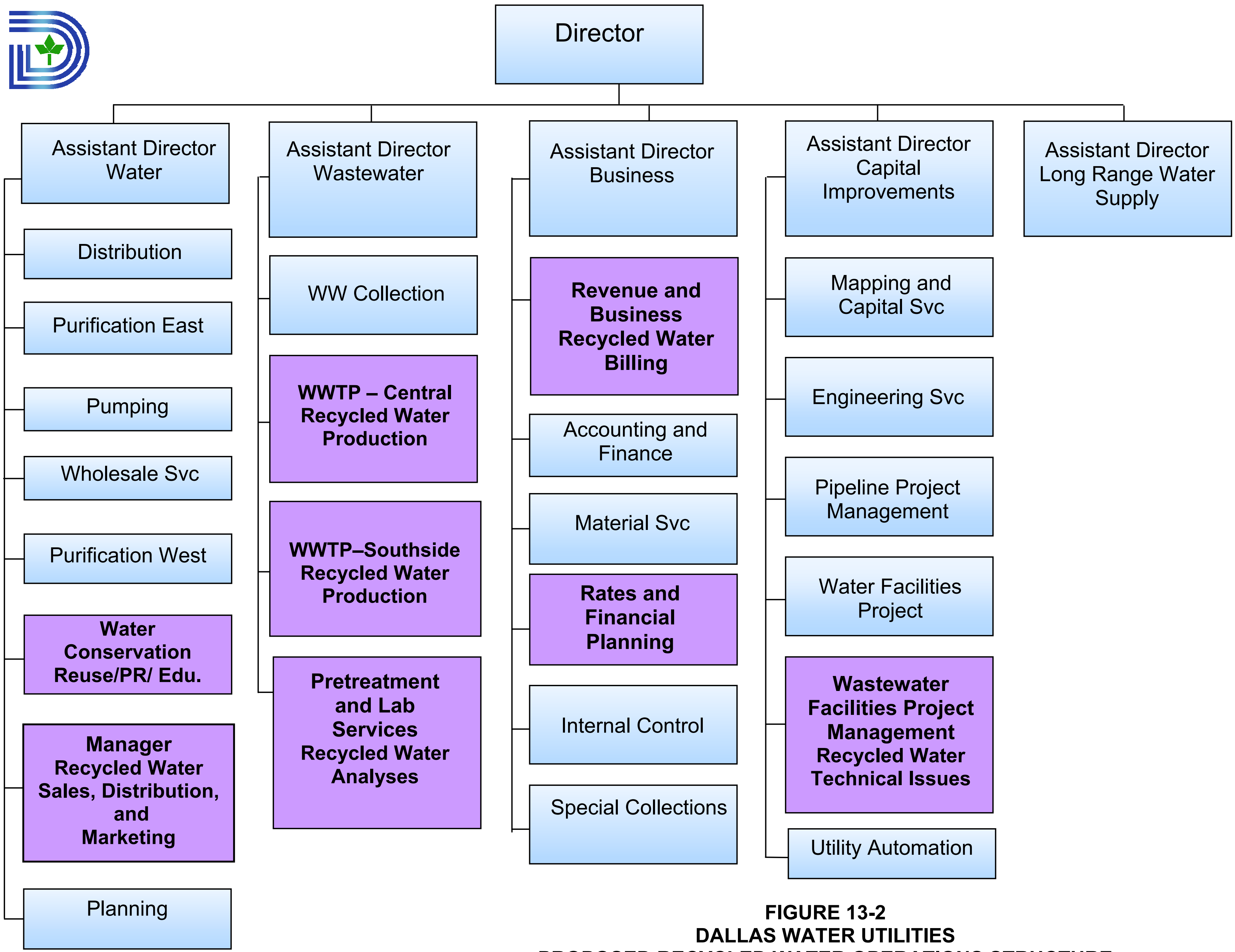


FIGURE 13-2
DALLAS WATER UTILITIES
PROPOSED RECYCLED WATER OPERATIONS STRUCTURE

(This page intentionally left blank.)

information/public awareness campaign (see Section 7.4), and coordinating with the Water Conservation Public Awareness Program and Five-Year Strategic Plan.

The staffing of the various positions will be phased as the recycled water program matures. The initial positions to be staffed during the fiscal year 2006-2007 timeframe may be the Program Manager, Marketing/Sales person, and a part-time Public Information/Awareness person.

Based on the advantages and disadvantages of the various alternatives, it is recommended that the functional (operations and maintenance) support may initially be assigned as follows and as illustrated in Figure 13-3:

1. Incorporate any wastewater treatment functions, whether at existing WWTPs or at satellite water factories, into the existing wastewater operations. (Note: Remote booster disinfection activities may be performed by the distribution system group.)

2. Transfer custody of the treated effluent to the existing water operations when the effluent enters a recycled water tank/reservoir.

3. Designate the pumping group of water operations to operate and maintain the recycled water tanks and pumping facilities.

4. Designate the distribution group of water operations to operate and maintain the recycled water distribution system including pipelines, tie-ins, metering facilities, and cross-connection inspection.

Policies and Procedures

The Recycled Water Program will require the development and implementation of a number of policies and procedures. The following presents a number of the types of considerations that to be covered by the policies and procedures.

- Infrastructure technical design specifications
- Cross-connection control requirements
- Funding sources and rules
- Rate structure
- Site inspection authority
- Enforcement policies
- Recycled Water Program operation and maintenance manual
- Recycled Water User manual
- Emergency Response Plan
- The development of these recycled water program policies and procedures should be coordinated with existing City of Dallas policies and procedures.

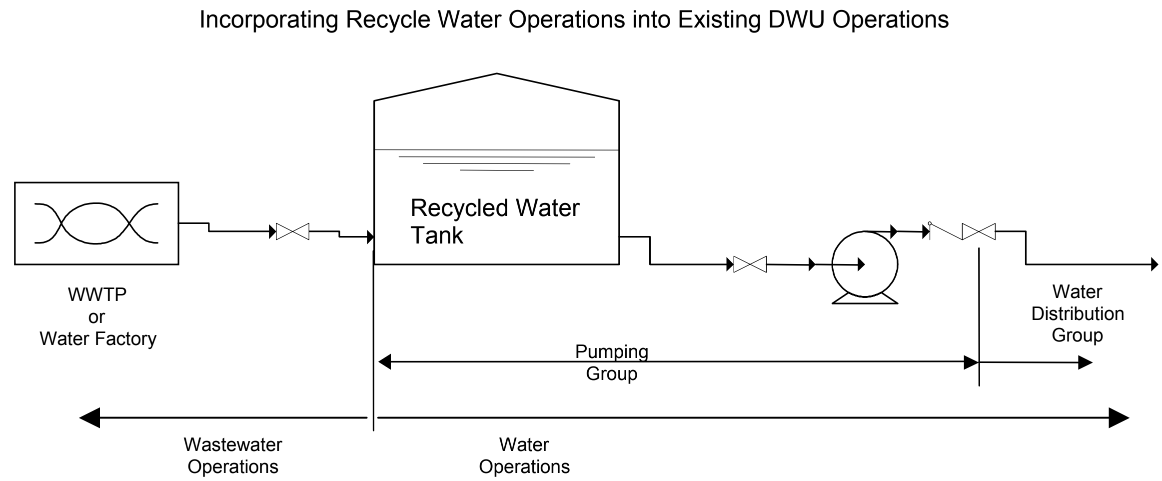


FIGURE 13-3
DWU RECYCLED WATER PROGRAM
PROPOSED OPERATIONS STRUCTURE

Update City Ordinances

The pricing of recycled water is currently established by Dallas City Code Chapter 49, Section 18.5 which includes the following statements: “Wastewater treatment plant effluent may be purchased for one-half of the regular rate for untreated (raw) water,” and “No distribution facilities will be provided by the City.”

It is recommended that Dallas consider updating the city code to make recycled water a valuable resource that is in high demand including:

- Setting the recycled water rate at 75 to 80 percent of the uninterruptible potable water rate;
- Restricting the sales of raw water within the targeted recycled water service areas water and contesting term water rights permits to discourage use of raw water for nonpotable uses; and
- Modifying the language of the Code to allow the City to participate in the financing of recycled water distribution projects as water supply alternatives.

It is important that the current zoning of areas that are considered for locating recycled water facilities be identified. In some cases zoning adjustments may be required and/or a Special Use Permit may be required.

Recycled Water Customer Contract

A standard contract to be executed with recycled water customers will be developed and adopted. The contract will include provisions necessary to address the following issues as well as other considerations typically included in DWU water customer contracts.

- Delineation of DWU’s and customer’s responsibilities
- Intended uses and description of areas of application of recycled water

- Uses prohibited
- Quantities of recycled water
- Price of recycled water
- Compliance with City rules, regulations, policies, and procedures
- Compliance with TCEQ rules and regulations
- Right for DWU to review and comment on customers' recycled water systems
- Right for DWU and plumbing inspection
- Enforcement provisions
- Facilities construction
- Delivery of recycled water
- Quantity and unit measurement
- Quality to be provided
- Pressure requirements
- Payments by purchaser
- Suspension of service
- Obligation of the parties
- Remedies upon default
- Procedures for contract amendment

Of major importance is that the contract includes provisions that protect the potable water system from cross connection with the recycled water.

13.2.2 Cedar Crest Golf Course Pilot Project

During the development of this project, DWU completed the design, construction and commissioning of the Cedar Crest Golf Course Pilot Project. DWU can use this project as a development tool and template for future recycled water projects. Much has been learned during the development and implementation of this project, and many of the assumptions and decisions can be reviewed and refined based on this experience and that of operating and maintaining the system.

Specifically, DWU should assess the completeness of the recycled water use agreement contract and amend the example standard agreement included in the Appendix as required. DWU should also review the policies and procedures being used for the pilot project and complete, amend, and refine them as necessary.

Another benefit that can be derived from the Cedar Crest Golf Course Pilot Project is development of information and actual operating and maintenance experience that can be used in marketing and public information campaigns. Public acceptance of recycled water projects will be critical to their success. The chief barrier to public acceptance of indirect potable reuse as a viable water supply is concern about potential adverse health effects associated with ingestion of recycled water. Developing a track record of safe, reliable and beneficial operations will contribute to the success of DWU's public acceptance efforts.

13.2.3 Wastewater Treatment Plant Testing Program

Based on a review of both historical and special recycled water project effluent monitoring at both Central and Southside, both plants have demonstrated the ability to meet the quality requirements for both Type I and Type II recycled water applications. In Type I applications, there is likely public contact in areas irrigated with recycled water. In Type II projects, public contact is controlled. The special monitoring for the recycled water project was done over a three-month period, and DWU has chosen to continue the monitoring on a weekly rather than the twice-weekly schedule followed initially. As the plants' flows increase, and approach their rated design capacities, careful observations should be made of the CBOD and turbidity levels. Any trends of increased concentrations should be addressed, possibly with optimization of operations or additional treatment capacity. Under the current flow and loading conditions, the effluent from either plant could be used for Type I or Type II recycled water projects.

13.2.4 Water Chapter 210 Reclaimed Use Notification

In February 2004, DWU submitted a Reclaimed Water Use Notification for the Cedar Crest Golf Course Pilot Project to TCEQ. DWU received approval for this project. This notification was for Type II recycled water uses. A revised Reclaimed Water Use Notification will need to be drafted and submitted to TCEQ for subsequent projects. This is a critical path item since approval is needed prior to the start of additional projects.

DWU will meet with TCEQ and then prepare and submit a Reclaimed Water Use Notification for the entire Recycled Water Program. DWU would then notify TCEQ as each project/phase of the program is implemented.

If DWU wishes to provide recycled water for Type I uses, the Reclaimed Water Use Notification will need to reflect requirements for those uses according to Title 30, TAC, Chapter 210. If the City's existing treatment facilities do not meet Type I effluent requirements at the time of startup of a Type I recycled water project, additional permit limits may be imposed on DWU by the TCEQ for Notification approval.

13.2.5 Public Information/Public Awareness Campaign

Since well-designed public outreach programs have been demonstrated to play a significant role in the success of recycled water projects, an important component of DWU's implementation plan will be developing an effective public outreach program. Such a program would inform stakeholders, solicit their input, and develop and enhance their support for the beneficial use of recycled water. This would typically include a Public Information Committee (PIC), specific to recycled water, at an appropriate time set by DWU. Currently, the PIC for recycled water is included in the PIC for the conservation plan and for the Long Range Water Supply Plan. The membership of a proposed PIC is also discussed below.

Public Information Committee

Based on the analyses of major water users and potential recycled water users developed for this implementation plan, a list of potential membership and/or invited guests for a new Public Information committee has been developed. A proposed PIC list is presented in Appendix A.

Public Announcements and Response

To ensure DWU recycled water projects are not misrepresented in the public domain, press releases should be used as a means of disseminating the project parameters accurately and the goals of the project.

Upon release of a recycled water project announcement in the press, the public and City leaders may have questions or be asked questions about the project. City staff and leaders will be made aware of and be briefed on the project to respond knowledgeably to public inquiries. An example of "Frequently Asked Questions" about recycled water uses is included in Appendix D. A "Glossary of Terms" that relate to recycled water projects are also included in Appendix C.

Coordinate with Water Conservation

The Water Conservation Public Awareness Program is ongoing and complementary to this project. The findings and recommendations of the Recycled Water Implementation Plan were incorporated in the Five-Year Strategic Plan on Water Conservation.

Stakeholder Workshops

DWU will work with and inform their customer cities and other stakeholders of the scope and implications of the recycled water program. In addition to their likely involvement in the Public Information Committee, DWU's customer cities and other stakeholders will be invited to participate in workshops to inform, encourage, and build consensus.

13.2.6 Market Sale Recycled Water

Identifying potential customers and understanding their needs and expectations are vital to successfully marketing recycled water. The potential customers identified in this report will be contacted directly, either through telephone contacts or by utilizing a standard letter and questionnaire, as projects are developed. A standard transmittal letter and questionnaire have been developed for distribution; see Appendices E and F, respectively. Analysis of the responses to the questionnaire will provide a more reliable basis for determining viable potential recycled water customers.

To make recycled water projects a success, recycled water needs to be marketed to targeted customers. The major goals of the initial marketing efforts will be to obtain recycled water subscriptions, further rank potential recycled water projects, and develop acceptance with the public. Therefore marketing and public relations will be an important component of implementation.

In conjunction with other polices and procedures, recycled water marketing material will be developed. Various marketing schemes and philosophies may be employed such as:

- News Media Applications
- Web Site Development
- Public Television
- Video Development

- Public Presentations
- Special Promotional Events (perhaps also incorporating water conservation)

Marketing surveys may also be employed to develop marketing materials through surveys to potential customers, businesses, stakeholders, and the general public.

13.2.7 Recycled Water Projects

This study has identified two direct, nonpotable recycled water projects that can be implemented, including:

1. Cedar Crest Pipeline Extension Project, Phase 1
2. White Rock Pipeline Alternative Project

Table 13-2 lists the conceptual capacity, and opinion of probable costs for capital facilities, annual O&M, and annual energy.

The recommendation to implement these two proposed recycled water projects is based on the likelihood of customer interest and feasibility of the projects. Further analysis is required to confirm the viability of these projects. For example, the potential customers identified in this report will be contacted directly to confirm their interest, needs and expectations. Additionally, detailed routing delineation should be performed along with surveying the route and development of easement descriptions. Subsequent to developing the survey and easement information, actions can be performed to acquire the right-of-way and required permits. The projects can then proceed into the design and construction phases.

A proposed schedule for implementing the proposed recycled water projects was shown on Figure 13-1.

13.2.8 Augmentation of Potable Water Supply

The scope of the Recycled Water Implementation Plan project was expanded to include the Raw Water Supply Augmentation Study that is tasked with investigating using recycled water to indirectly augment DWU's potable supply. The findings and recommendations of the augmentation study will be provided in Volume 2 of this report. However, initial work on the augmentation project has provided information to this study. Findings and recommendations from both studies will be coordinated.

Recycled water augmentation of DWU's potable water reservoirs has significant potential for providing DWU with an affordable source of water, acting as an alternative raw water supply. This potential may be confirmed and/or enhanced by future water and wastewater treatment technologies.

DWU has submitted a Water Rights permit to TCEQ to retain ownership of the City's recycled water. Obtaining clear ownership of this water is critical to any significant augmentation project or other major recycled water project.

TABLE 13-2 Recommended Recycled Water Projects						
Projects	Identified Average Usage	Projected Average Supply	System Capacity	Capital Costs	O & M Costs	Energy Costs
	[MGD]	[MGD]	[MGD]	[$MM]	Annual	Annual
Cedar Crest Pipeline Extend pipeline to Zoo, Rock-Tenn Area	1.74	1.75	3.50	$ 6.50	$ 162,500	$ 60,168
White Rock Pipeline Alternate	7.37	16.50	30.00	$55.20	$1,380,000	$825,159
Recommended Recycled Water System	9.11	18.25	33.50	$61.70	$1,542,500	$885,327

(This page was intentionally left blank.

APPENDIX A

SUGGESTED STAKEHOLDER GROUPS TO BE REPRESENTED ON PUBLIC INFORMATION COMMITTEE

Potential Stakeholder Groups	Potential Members of the Stakeholder Groups
Public School Districts	Dallas, Richardson, Plano
Colleges	Dallas County Community Colleges, UT Dallas, SMU, Paul Quinn, UNT Dallas, TAMU Extension
Commercial & Industrial Users	TI, TXU Energy, Vought Aircraft, Rock-Tenn, Greater Dallas Chamber of Commerce
Food Producers	Americana Foods, Borden, Coca Cola Bottling, Pilgrims Pride, Quaker Oats, Schepps-Foremost
Commercial Real Estate Developers	The Real Estate Council, North TX. Commercial Assoc. of Realtors, Business Owners & Managers Association
Hotels	Greater Dallas Hotel-Motel Assoc., Adam's Mark, Adolphus, Crescent, Doubletree, Fairmount, Hyatt Regency, Wyndam, other large chains
Airports	DFW International, Love Field, Dallas Executive
Landscape & Irrigation Professional Associations	ALSA – DFW Section Dallas Irrigation Association
Transportation Agencies	DART, TxDOT, NTTA
Hospitals	Baylor Hospital, Childrens Medical, Medical City Dallas, Methodist Hospitals, Presbyterian Hospitals, UT Southwestern Medical Center, VA
Parks and Golf Courses	Dallas PARD (includes the Arboretum and Dallas Zoo), private golf courses
Environmental Advocates and Conservationists	Sierra Club, TCONR, League of Women Voters
Science & Environmental Museums	The Science Place, Texas Discovery Gardens
Faith-based organizations	Greater Dallas Community of Churches, Jewish Federation of Dallas, Catholic Diocese, Episcopal Diocese

(This page intentionally left blank.).

Table B-1
Cedar Crest Corridor Service Area

Owner: Dallas Water Utilities
Amount: 2.25 MGD

PIPELINE	Size	Quantity	Unit	Unit Price	Cost
Phase I					
Pipeline (Urban-street)	20"	15,100	LF	$225	$3,397,500
Pipeline (Urban-street)	12"	1,700	LF	$175	$297,500
Phase I Pipeline Subtotal					$3,695,000
Engineering and Contingencies (30%)					$1,108,500
Phase I Pipeline Total					$4,803,500
Phase II					
Pipeline (Urban-street)	16"	15,000	LF	$200	$3,000,000
Pipeline (Urban-street)	12"	1,150	LF	$175	$201,300
Phase II Pipeline Subtotal					$3,201,300
Engineering and Contingencies (30%)					$960,390
Phase II Pipeline Total					$4,161,690
Pipeline Total					**$8,965,190**
PUMP STATION					
Pumps (including Building)					$1,300,000
Engineering and Contingencies (30%)					$390,000
Pump Station Total					$1,690,000
Pump Station Total					**$1,690,000**
CONSTRUCTION TOTAL					**$10,655,190**
ANNUAL COSTS					
Debt Service (5% for 30 years)					$693,100
Electricity ($0.06 kWh)					$77,400
O&M Pipelines (2.5% of capital cost)					$224,100
O&M Pump Station (2.5% of capital cost)					$42,300
Total Annual Costs (Years 1-30)					**$1,036,900**
Total Annual Costs (Years 31-50)					**$343,800**
UNIT COSTS					
Per 1,000 Gallons (30-yr)					$1.26
Per 1,000 Gallons (50-yr)					$0.93

(This page intentionally left blank.).

Table B-2
Lower White Rock Service Area

Owner: Dallas Water Utilities
Amount: 2.50 MGD

PIPELINE	Size	Quantity	Unit	Unit Price	Cost
Phase I					
Pipeline (Urban-street)	16"	2,650	LF	$200	$530,000
Pipeline (Urban-street)	12"	5,550	LF	$175	$971,300
Phase I Pipeline Subtotal					$1,501,300
Engineering and Contingencies (30%)					$450,390
Phase I Pipeline Total					$1,951,690
Phase II					
Pipeline (Urban-street)	16"	10,000	LF	$200	$2,000,000
Phase II Pipeline Subtotal					$2,000,000
Engineering and Contingencies (30%)					$600,000
Phase II Pipeline Total					$2,600,000
Phase III					
Pipeline (Urban-street)	12"	6,300	LF	$175	$1,102,500
Phase III Pipeline Subtotal					$1,102,500
Engineering and Contingencies (30%)					$330,750
Phase III Pipeline Total					$1,433,250
Phase IV					
Pipeline (Urban-street)	12"	2,850	LF	$175	$498,800
Phase IV Pipeline Subtotal					$498,800
Engineering and Contingencies (30%)					$149,640
Phase IV Pipeline Total					$648,440
Pipeline Total					**$6,633,380**

WATER FACTORY	Size	Quantity	Unit	Unit Price	Cost
Screen					$280,000
MBR	5 mgd				$8,400,000
Disinfection					$370,000
Electrical					$905,000
Building					$160,000
SCADA					$160,000
Pump Station					$1,400,000
Storage Tank	2.5 mgd				$900,000
Odor Control					$250,000
Water Factory Subtotal					$12,825,000
Engineering and Contingencies (30%)					$3,847,500
Water Factory Total					$16,672,500
Water Factory Total					**$16,672,500**
CONSTRUCTION TOTAL					**$23,305,880**

Table B-2
Lower White Rock Service Area

ANNUAL COSTS	
Debt Service (5% for 30 years)	$1,516,100
Electricity ($0.06 kWh)	$103,145
O&M Pipelines (2.5% of capital cost)	$165,800
O&M Pump Station (2.5% of capital cost)	$416,800
Total Annual Costs (Years 1-30)	**$2,201,845**
Total Annual Costs (Years 31-50)	**$685,745**
UNIT COSTS	
Per 1,000 Gallons (30-yr)	$2.41
Per 1,000 Gallons (50-yr)	$1.75

Table B-3
Upper White Rock Service Area

Owner: Dallas Water Utilities
Amount: 7.50 MGD

PIPELINE	Size	Quantity	Unit	Unit Price	Cost
Phase I					
Pipeline (Urban-street)	24"	9,200	LF	$250	$2,300,000
Phase I Pipeline Subtotal					$2,300,000
Engineering and Contingencies (30%)					$690,000
Phase I Pipeline Total					$2,990,000
Phase II					
Pipeline (Urban-street)	20"	6,225	LF	$225	$1,400,600
Phase II Pipeline Subtotal					$1,400,600
Engineering and Contingencies (30%)					$420,180
Phase II Pipeline Total					$1,820,780
Phase III					
Pipeline (Urban-street)	16"	5,700	LF	$200	$1,140,000
Pipeline (Urban-street)	12"	1,500	LF	$175	$262,500
Phase III Pipeline Subtotal					$1,402,500
Engineering and Contingencies (30%)					$420,750
Phase III Pipeline Total					$1,823,250
Phase IV					
Pipeline (Urban-street)	12"	5,150	LF	$175	$901,300
Phase IV Pipeline Subtotal					$901,300
Engineering and Contingencies (30%)					$270,390
Phase IV Pipeline Total					$1,171,690
Phase V					
Pipeline (Urban-street)	16"	11,500	LF	$200	$2,300,000
Phase V Pipeline Subtotal					$2,300,000
Engineering and Contingencies (30%)					$690,000
Phase V Pipeline Total					$2,990,000
Pipeline Total					**$10,795,720**

Table B-3
Upper White Rock Service Area

WATER FACTORY	Size	Quantity	Unit	Unit Price	Cost
Screen					$500,000
MBR	15 mgd				$14,000,000
Disinfection					$700,000
Electrical					$1,520,000
Building					$250,000
SCADA					$250,000
Pump Station					$3,000,000
Storage Tank	5 mgd				$2,000,000
Odor Control					$400,000
Water Factory Subtotal					$22,620,000
Engineering and Contingencies (30%)					$6,786,000
Water Factory Total					$29,406,000
Water Factory Total					**$29,406,000**
CONSTRUCTION TOTAL					**$40,201,720**
ANNUAL COSTS					
Debt Service (5% for 30 years)					$2,615,200
Electricity ($0.06 kWh)					$412,579
O&M Pipelines (2.5% of capital cost)					$269,900
O&M Pump Station (2.5% of capital cost)					$735,200
Total Annual Costs (Years 1-30)					**$4,032,879**
Total Annual Costs (Years 31-50)					**$1,417,679**
UNIT COSTS					
Per 1,000 Gallons (30-yr)					$1.47
Per 1,000 Gallons (50-yr)					$1.09

Table B-4
White Rock Pipeline Alternative

Owner: Dallas Water Utilities
Amount: 16.50 MGD

PIPELINE	**Size**	**Quantity**	**Unit**	**Unit Price**	**Cost**
Phase I					
Pipeline (Urban)	42"	22,600	LF	$205	$4,633,000
Pipeline (Urban)	42"	5,200	LF	$205	$1,066,000
Pipeline (Urban-street)	12"	7,500	LF	$175	$1,312,500
Pipeline (Urban)	42"	6,750	LF	$205	$1,383,800
Pipeline (Urban)	42"	17,500	LF	$205	$3,587,500
Pipeline (Urban-street)	12"	5,050	LF	$175	$883,800
Pipeline (Urban-street)	36"	19,500	LF	$270	$5,265,000
Pipeline (Urban-street)	16"	7,500	LF	$200	$1,500,000
Pipeline (Urban)	36"	10,750	LF	$175	$1,881,300
Pipeline (Urban-street)	24"	10,000	LF	$250	$2,500,000
Pipeline (Urban-street)	36"	27,600	LF	$270	$7,452,000
Phase I Pipeline Subtotal					$31,464,900
Engineering and Contingencies (30%)					$9,439,470
Phase I Pipeline Total					$40,904,370
Pipeline Total					**$40,904,370**

PUMP STATION(S)	**Size**	**Quantity**	**Unit**	**Unit Price**	**Cost**
Central WWTP Pump Station	30 mgd				
Civil					$670,000
Structural					$970,000
Architectural					$230,000
Mechanical					$1,050,000
Electrical					$1,580,000
Storage	5 mgd				$1,000,000
Central WWTP Pump Station Subtotal					$5,500,000
Engineering and Contingencies (30%)					$1,650,000
Central WWTP Pump Station Total					$7,150,000
Booster Pump Station	30 mgd				
Civil					$670,000
Structural					$970,000
Architectural					$230,000
Mechanical					$1,050,000
Electrical					$1,580,000
Storage	5 mgd				$1,000,000
Booster Pump Station Subtotal					$5,500,000
Engineering and Contingencies (30%)					$1,650,000
Booster Pump Station Total					$7,150,000
Pump Station(s) Total					**$14,300,000**
CONSTRUCTION TOTAL					**$55,204,370**

Table B-4
White Rock Pipeline Alternative

ANNUAL COSTS	
Debt Service (5% for 30 years)	$3,591,100
Electricity ($0.06 kWh)	$825,159
O&M Pipelines (2.5% of capital cost)	$1,022,600
O&M Pump Station (2.5% of capital cost)	$357,500
Total Annual Costs (Years 1-30)	**$5,796,359**
Total Annual Costs (Years 31-50)	**$2,205,259**
UNIT COSTS	
Per 1,000 Gallons (30-yr)	$0.96
Per 1,000 Gallons (50-yr)	$0.72

Table B-5
Love Field Service Area

Owner: Dallas Water Utilities
Amount: 2.25 MGD

PIPELINE	Size	Quantity	Unit	Unit Price	Cost
Phase I					
Pipeline (Urban-street)	16"	5,000	LF	$200	$1,000,000
Phase I Pipeline Subtotal					$1,000,000
Engineering and Contingencies (30%)					$300,000
Phase I Pipeline Total					$1,300,000
Phase II					
Pipeline (Urban-street)	16"	11,000	LF	$200	$2,200,000
Phase II Pipeline Subtotal					$2,200,000
Engineering and Contingencies (30%)					$660,000
Phase II Pipeline Total					$2,860,000
Phase III					
Pipeline (Urban-street)	16"	3,800	LF	$200	$760,000
Pipeline (Urban-street)	12"	3,650	LF	$175	$638,800
Phase III Pipeline Subtotal					$1,398,800
Engineering and Contingencies (30%)					$419,640
Phase III Pipeline Total					$1,818,440
Phase IV					
Pipeline (Urban-street)	12"	4,000	LF	$175	$700,000
Phase IV Pipeline Subtotal					$700,000
Engineering and Contingencies (30%)					$210,000
Phase IV Pipeline Total					$910,000
Pipeline Total					**$6,888,440**
WATER FACTORY	**Size**	**Quantity**	**Unit**	**Unit Price**	**Cost**
Screen					$265,000
MBR	4.5 mgd				$7,700,000
Disinfection					$345,000
Electrical					$831,000
Building					$155,000
SCADA					$155,000
Pump Station					$1,300,000
Storage Tank	2 mgd				$750,000
Odor Control					$230,000
Water Factory Subtotal					$11,731,000
Engineering and Contingencies (30%)					$3,519,300
Water Factory Total					$15,250,300
Water Factory Total					**$15,250,300**
CONSTRUCTION TOTAL					**$22,138,740**

Table B-5
Love Field Service Area

ANNUAL COSTS	
Debt Service (5% for 30 years)	$1,440,200
Electricity ($0.06 kWh)	$77,359
O&M Pipelines (2.5% of capital cost)	$172,200
O&M Pump Station (2.5% of capital cost)	$381,300
Total Annual Costs (Years 1-30)	**$2,071,059**
Total Annual Costs (Years 31-50)	**$630,859**
UNIT COSTS	
Per 1,000 Gallons (30-yr)	$2.52
Per 1,000 Gallons (50-yr)	$1.82

Table B-6
Southwest Dallas Service Area

Owner: Dallas Water Utilities
Amount: 1.00 MGD

PIPELINE	Size	Quantity	Unit	Unit Price	Cost
Phase I					
Pipeline (Urban-street)	12"	18,850	LF	$175	$3,298,800
Phase I Pipeline Subtotal					$3,298,800
Engineering and Contingencies (30%)					$989,640
Phase I Pipeline Total					$4,288,440
Phase II					
Pipeline (Urban-street)	12"	6,850	LF	$175	$1,198,800
Phase II Pipeline Subtotal					$1,198,800
Engineering and Contingencies (30%)					$359,640
Phase II Pipeline Total					$1,558,440
Phase III					
Pipeline (Urban-street)	12"	9,150	LF	$175	$1,601,300
Phase III Pipeline Subtotal					$1,601,300
Engineering and Contingencies (30%)					$480,390
Phase III Pipeline Total					$2,081,690
Pipeline Total					**$7,928,570**

WATER FACTORY	Size	Quantity	Unit	Unit Price	Cost
Screen					$180,000
MBR	2 mgd				$4,200,000
Disinfection					$250,000
Electrical					$463,000
Building					$130,000
SCADA					$130,000
Pump Station					$650,000
Storage Tank	1 mgd				$450,000
Odor Control					$150,000
Water Factory Subtotal					$6,603,000
Engineering and Contingencies (30%)					$1,980,900
Water Factory Total					$8,583,900
Water Factory Total					**$8,583,900**
CONSTRUCTION TOTAL					**$16,512,470**

Table B-6
Southwest Dallas Service Area

ANNUAL COSTS	
Debt Service (5% for 30 years)	$1,074,200
Electricity ($0.06 kWh)	$44,696
O&M Pipelines (2.5% of capital cost)	$198,200
O&M Pump Station (2.5% of capital cost)	$214,600
Total Annual Costs (Years 1-30)	**$1,531,696**
Total Annual Costs (Years 31-50)	**$457,496**
UNIT COSTS	
Per 1,000 Gallons (30-yr)	$4.20
Per 1,000 Gallons (50-yr)	$3.02

APPENDIX C

GLOSSARY OF TERMS

- A -

Advanced Treatment – wastewater treatment processes beyond conventional treatment including but not limited to such processes as ultrafiltration, microfiltration, nanofiltration, reverse osmosis, electrodialysis, ion exchange, carbon absorption (granular activated or powdered activated), chemical oxidation, nitrification, coagulation and flocculation, gravity filtration, nutrient removal (biological and/or chemical), air stripping, lime treatment). Also known as tertiary treatment. [NRC, 22-23; Dual, 81]

Agricultural Reuse on Food Crops – irrigation of food crops which are intended for direct human consumption, often further classified as to whether the food crop is to be processed or consumed raw. [Review, 2]

Agricultural Reuse on Nonfood Crops – irrigation of fodder, fiber, and seed crops, pasture land, commercial nurseries, and sod farms. [Review, 2]

Augmentation of Potable Water Supplies – see indirect potable reuse.

- B -

Backflow Prevention – means the installation of a device to prevent potential backflow of fluid or other contaminates into the potable water system and/or the reclaimed water system in the event that an inadvertent or illegal interconnection occurs with any nonpotable system. Accepted backflow prevention methods include: air gap, reduced pressure principle backflow assembly, double check value assembly. Other approved devices that may be used for additional protection of the potable water system and/or the quality and integrity of the reclaimed water system include: pressure vacuum breakers and atmospheric vacuum breakers as approved by the Foundation of Cross Connection Control and Hydraulic Research of the University of Southern California, as outlined in Section 10 of the most current issues of the "Manual of Cross Connection Control." [Guidelines, 52]

Bed and Banks Authorization – authorization to convey treated wastewater in a stream or other state watercourse and then subsequently divert and reuse the water. [30 TAC § 297.16]

Beneficial Use – an economic use of wastewater in accordance with the purposes, applicable requirements, and quality criteria of 30 TAC Chapter 210, and which takes the place of potable and/or raw water that could otherwise be needed from another source. The use of reclaimed water in a quantity either less than or the economically optimal amount may be considered a beneficial use as long as it does not constitutes a nuisance. [30 TAC §210.3]

Blow-offs – even with sufficient disinfection, residual organics and bacteria may accumulate and/or grow at dead spots in the system. This may lead to odor and clogging problems. Blow-off valves and blow-off periodic maintenance of the system can significantly allay the problem.

In most cases, the blow-off flow is directed into the sewage system and/or pervious areas such as parkways, easements, right-a-ways, parks and other managed receiving areas. [Guidelines, 53]

BOD_5 – biochemical oxygen demand. Used to assess the total amount of organics present. BOD is an index of the biodegradable organics, oil, and grease. It is a measure of the relative oxygen requirements of wastewaters, effluents, and polluted waters. [Dual, 81]

- C -

$CBOD_5$ – carbonaceous biochemical oxygen demand. $CBOD_5$ is the part of BOD due strictly to organic matter rather than ammonia. The BOD test is run with an inhibitor for nitrification. [Manual, 663]

CFU – colony forming units. Number of bacterial colonies formed on media inoculated with a water sample. Fecal coliform CFU standards are set for recycle water depending on the intended use of the water.

Conservation – 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. [30 TAC §297.1]

Conventional Treatment – wastewater treatment typically including preliminary, primary, and secondary (biological) treatment processes.

Cross Connections – of unknown or unsafe quality, which may be capable of conveying contaminates to the public water supply as a result of backflow. Arrangements such as bypass, jumper connections, removable sections, swivel or changeable devices and other temporary or permanent devices through which or because of, backflow could occur or considered to be cross connections. [Manual, 664]

- D -

Direct Nonpotable Reuse – use of community wastewater treated to a sufficient degree that they are acceptable for a wide range of nonpotable uses and direct discharge into a nonpotable distribution system that provides service to customers who obtain their potable water from a separate system. [Dual, 81]

Direct Potable Reuse – immediate addition of reclaimed wastewater to the water distribution system. This practice has not been adopted by, or approved for, any water system in the United States. [NRC, 21]

Disinfection – the destruction of pathogenic organisms by chemical, physical, or biological means. [Dual, 81]

Domestic Wastewater – waste and wastewater from humans or household operations that are discharged to a wastewater collection system or otherwise enters a treatment works. Also, this includes water borne human waste and waste from domestic activities such as washing, bathing, and food preparation, including greywater and blackwater, that is disposed in an on-site wastewater system as defined in 30 TAC Chapter 285. [30 TAC §210.3]

Dual Water Systems – facilities that distribute two grades of water to the same service area – meeting all State and Federal requirements for human or animal ingestion and the other meeting State requirements for nonpotable applications. The quality, quantity, and pressure available from each system vary with the sources and intended uses for each grade of water. [Dual, 81]

- E -

Endocrine Disrupters – a group of various environmental contaminants also known as "hormonally active agents" which are associated with adverse reproductive and developmental effects in wildlife, humans, and laboratory animals. The contaminants may mimic the effects of the female sex hormone estradiol or antagonize the action of natural hormones and include such compounds as PCBs, PCDFs, synthetic pesticides (e.g., DDT, DDE, lindane, methoxychlor), dioxin, phthalates, other synthetic organic compounds, alkylphenol ethoxylate (solvent/emulsifier/plasticizer), natural hormones, and synthetic hormones such as ethinylestradiol (birth control pill ingredient). It should be noted that the cause and effect relationships associated with this group of compounds is difficult to define and undergoing much evaluation at this time. [Safe, 1-3; Committee on HAA, 16-20; EPA, 2]

Environmental Reuse – reclaimed water used to create man-made wetlands, enhance natural wetlands, and to sustain stream flows. [Review, 2]

Epidemiological Studies – studies examining the relationship between contaminants in drinking water and health problems. [Issues, 11]

- F -

Food Crop – any crops intended for direct human consumption. [30 TAC §210.3]

- G -

Geometric Mean – the n^{th} root of the product of all measurements made in a particular period of time, for example in a month's time, where n equals the number of measurements made. In the alternative, the geometric mean can also be computed as the antilogarithm of the sum of the logarithm of each measurement made. Where any measurement using either computation method equals zero, it must be substituted with the value of one. [30 TAC §210.3]

Groundwater Recharge – replenishing groundwater potable water aquifers either through spreading the recycle water on the ground above the aquifers or directly injecting the recycle water into the aquifer. [Issues, 32]

- I -

Indirect Potable Water Reuse – abstraction, treatment, and distribution of water for drinking from a natural source water that is fed (augmented) in part by the discharge of wastewater effluent. [NRC, 20]

Industrial Reuse – reclaimed water used in industrial facilities primarily for cooling system makeup water, boiler-geed water, process water, and general washdown. [Review, 2]

Initial Holding Pond – an impoundment which first receives reclaimed water from a producer at the quality levels established by 30 TAC Chapter 210, not including subsequent holding ponds. [30 TAC §210.3]

Interruptible Source – water supply that can be limited to specific parts of the day or supply periods.

- L -

Landscape Impoundment – body of reclaimed water that is used for aesthetic enjoyment or which otherwise serves a function not intended to include contact recreation. [30 TAC §210.3]

Leak Detection System – a system or device designed, constructed, maintained, and operated with a pond that is capable of immediately detecting a release of leachate or reclaimed water that migrates through a liner. The system may typically include a leachate collection system along with either leak detection sensors or view ports. [30 TAC §210.3]

- M -

Membrane Treatment – advanced treatment processes including microfiltration, ultrafiltration, nanofiltration, reverse osmosis, and electrodialysis. Contaminants are removed from the liquid through straining at various synthetic membrane pore sizes.

Municipal Wastewater – waste or wastewater discharged into a publicly owned or a privately owned sewerage treatment works primarily consisting of domestic waste. [30 TAC §210.3]

- N -

Nonpotable Water – means not suitable for consumption by humans or animals and should not be used for the purposes of augmenting or filling of swimming pools where extended human contact time could result. [Dual, 81]

NTU – ***Nephelometric Turbidity Units***. Units of measure used to denote turbidity in water.

Nuisance – any distribution, storage, or use of reclaimed water, in such concentration and of such duration that is or may tend to be injurious to or which adversely affects human health or welfare, animal life, vegetation, or property, or which interferes with the normal use and enjoyment of animal life, vegetation, or property.

- O -

On-channel Pond – an impoundment wholly or partially within a definite channel of a stream in which water flows within a defined bed and bans, originating from a definite source or sources. The water may flow continuously or intermittently, and if intermittently, with some degree of regularity, dependent on the characteristics of the source or sources. [30 TAC §210.3]

- P -

Pharmaceutically Active Compounds – a group of compounds including antibiotics, drugs, and synthetic hormones that have recently been shown to be present in the effluents from wastewater treatment plants. These compounds are of concern from both the environmental impact perspective and the potential impacts in water reuse projects. [Sedlak, 1]

Planned Indirect Potable Water Reuse – purposeful augmentation of a water supply source with reclaimed water derived from treated municipal wastewater. The water receives additional treatment prior to distribution. [NRC, 20]

Potable Water – water of high quality intended for drinking, cooking, and cleansing. This grade of water would conform to the drinking-water quality requirements of state and federal regulatory agencies. [Dual, 82]

Preliminary Treatment – includes initial screening of wastewater to remove rags and large objects, frequently followed by grit removal to separate sand and heavier solids from the wastewater. [Issues, 21]

Primary Drinking Water Standards – National Primary Drinking Water Regulations are legally enforceable standards that apply to public water systems. Primary standards protect public health by limiting the levels of contaminants in drinking water. Microbial contaminants, disinfection byproducts, select disinfectants, inorganic contaminants (select metals, fluoride, asbestos, nitrite, and nitrate), select organic chemicals, and select radionuclides are included in the list of primary drinking water standards. [40 CFR Part 141, 30 TAC §290.104]

Primary Treatment – usually a physical settling process but may include chemical enhancement to remove slightly more than half of the suspended solids and about one-third of the biodegradable organic material as well as some nutrients, pathogenic organisms, trace elements, and potentially toxic organic compounds. [Issues, 21]

Producer – a person or entity that produces reclaimed water by treating domestic wastewater or municipal wastewater, in accordance with a permit or other authorization of the Agency, to meet the quality criteria established in 30 TAC Chapter 210. [30 TAC §210.3]

Provider – a person or entity that distributes reclaimed water to a user(s) of reclaimed water. For purposes of 30 TAC Chapter 210, the reclaimed water provider may also be a reclaimed water producer. [30 TAC §210.3]

- R -

Reclaimed Water – domestic or municipal wastewater which has been treated to a quality suitable for a beneficial use, pursuant to the provisions of 30 TAC Chapter 210 and other applicable rules and permits. [30 TAC §210.3]

Recycled Water – see reclaimed water.

Return Flow – discharge of treated wastewater into a receiving stream.

Restricted Landscaped Area – land that has vegetative cover to which public access is controlled in some manner. Access may be controlled by either legal means (e.g., state or city ordinance) or controlled by some type of physical barrier (e.g., fence or wall). Examples of such areas are: golf courses, cemeteries, roadway rights-of-way, and median dividers. [30 TAC §210.3]

Restricted Recreational Impoundment – body of reclaimed water in which recreation is limited to fishing, boating and other non-contact recreational activities. [30 TAC §210.3]

- S -

Secondary/Biological Treatment – treatment processes involving microorganisms that oxidize organic material to produce carbon dioxide and other end products. A portion of the organic material is used by the microorganisms for energy. Biological treatment and the subsequent solids separation process can remove up to 95 percent of the BOD and TSS entering the process along with significant amounts of heavy metals and certain organic compounds. [Issues, 21]

Secondary Drinking Water Standards – National Secondary Drinking Water Regulations (NSDWRs or secondary standards) are nonenforceable guidelines regulating contaminants that may cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as taste, odor, or color) in drinking water. EPA recommends secondary standards to water systems but does not require systems to comply. However, states may choose to adopt them as enforceable standards. [40 CFR Part 143, 30 TAC §290.105]

Single Grab Sample – an individual sample collected in less than 15 minutes. [30 TAC §210.3]

Spray Irrigation – application of finely divided water droplets using artificial means. [30 TAC §210.3]

Subsequent Holding Pond – a pond or impoundment that receives reclaimed water from an initial holding pond where the quality of the water changes after management in the initial holding pond. [30 TAC §210.3]

Surface Water Augmentation – addition of reclaimed water into a drinking water reservoir to mix with the water supply source prior to the mix being treated at a conventional water treatment plant. [Storage, 3-2]

- T -

Tertiary Treatment – see advanced wastewater treatment.

Total Dissolved Solids – the material residue left in the glassware after filtered sample evaporation and drying in an oven at a defined temperature.

Total Suspended Solids – the solid matter suspended in water or wastewater. Suspended solids are the portion of total solids retained by the filter during filtration of a sample. [Dual, 83]

Total Solids – the material residue left in the glassware after sample evaporation and drying in an oven at a defined temperature. Includes both suspended and dissolved solids. [Dual. 83]

Turbidity – the measure of the clarity of water. Turbidity refers to the presence of suspended materials in water that interfere with the passage of light through the water. Turbidity may be caused by inorganic or organic particulates or the presence of microorganisms. Turbidity is typically expresses in terms of nephelometric turbidity units or NTUs. [Chemistry, 331-332]

Type I Reclaimed Water – use of reclaimed water where contact between humans and the reclaimed water is likely. [30 TAC §210.3]

Type II Reclaimed Water – use of reclaimed water where contact between humans and the reclaimed water is unlikely. [30 TAC §210.3]

- U -

Unplanned Indirect Potable Water Reuse – the unintentional addition of wastewater (treated or not) to a water supply that is subsequently used (usually by downstream communities) as a water source, with additional treatment prior to delivery. Many communities already unintentionally practice such unplanned indirect potable reuse. [NRC, 21]

Unrestricted Landscaped Area – land that has had its plant cover modified and access to which is uncontrolled. Examples of such areas are: parks, schoolyards, greenbelts, and residences. [30 TAC §210.3]

Unrestricted Recreational Reuse – an impoundment of water in which no limitations are imposed on body-contact water recreation activities. [Review, 2]

REFERENCES

American Water Works Association. *Manual of Water Supply Practices. Dual Water Systems.* AWWAM24. Denver, CO. AWWA. 1994 [Dual]

Code of Federal Regulations. [CFR]

Crook, James, Ph.D., P.E.; Ammerman, David K, P.E.; Okun, ScD, P.E.; and Matthews, Robert L., PE. *Guidelines for Water Reuse*. EPA/625/R-92/004. [Guidelines]

Crook, James; Okun, Daniel A., and Pincince, Albert B. *Water Reuse*. Alexandria, VA. Water Environment Research Foundation. 1994. [Reuse]

Environmental Protection Agency. *Removal of Endocrine Disruptor Chemicals Using Drinking Water Treatment Processes*. Cincinnati, OH. EPA/625/R-00/015. [EPA]

Miller, Gerald, Ph.D.; Bosch, Richard ten, P.E.; Horne, Alex, Ph.D; Lazenby, Andrew; Quinlan, Elizabeth; and Spangenberg, Carl, P.E. *Impact of Surface Storage on Reclaimed Water: Seasonal and Long Term*. Alexandria, VA. Water Environment Research Foundation. 2003. [Storage]

National Research Council. *Hormonally Active Agents in the Environment*. Executive Summary. Washington, D.C. National Academy Press. 1999 [Committee on HAA]

National Research Council. *Issues in Potable Reuse. The Viability of Augmenting Drinking Water Supplies with Reclaimed Water*. Washington, D.C. National Academy Press. 1998. [Issues]

Going, Victor, and Ammerman, David K. "*Review of Regulations and Guidelines for Water Reuse Across the United States.*" WateReuse Association. 2003 Symposium.

Safe, Stephen. H. "*Endocrine Disruptors and Human Health – Is There a Problem? An Update.*" Environmental Health Perspectives, Volume 108, Number 6, June 2000. [Safe]

Sedlak, David L. "*Should We Worry About Estrogenic Hormones and other Pharmaceutically Active Compounds in the Aquatic Environment?*" Encodrine Disruptors and Pharmaceutically Active Compounds in Drinking Water. Seminar co-sponsored by AWWARF, WERF, WateReuse Foundation. 2000. [Sedlak]

Texas Administrative Code. [TAC]

Texas Water Utilities Association. *Manual of Wastewater Treatment*. 4th Edition. Austin, TX. TWUA. 1991. [Manual]

APPENDIX D

RECYCLE WATER PERSPECTIVES
FREQUENTLY ASKED QUESTIONS BY THE PUBLIC AND POLITICIANS

1. What is reclaimed water used for?

   A. Planned uses generally include nonpotable water supply

      1. Parks Irrigation
      2. Schools Irrigation
      3. Golf Course Irrigation
      4. Commercial and Industrial Uses (i.e., cooling water)

   B. Unplanned uses include augmentation of potable supplies by discharging into reservoirs and/or streams with a downstream diversion for potable use.

2. Will reclaimed water harm the grasses or landscaping?

   A. Requires analyzing the quality of the water particularly with respect to “salt” content.

   B. There are numerous applications that have not harmed the grasses or landscaped areas.

3. Is the reclaimed water safe?

   Yes, regulations require advanced treatment levels for different uses (i.e., Type I and Type II)

4. Is the reclaimed water more economical than other water?

   A. Not generally more economical than ground water or raw surface water.

   B. It is more economical than potable water in many situations – requires site-specific analysis.

5. What are the major benefits of reclaimed water?

   A. More economical in some cases.

   B. Provides a dependable supply.

6. Can reclaimed water be used for potable supply?

   A. Not for direct use (e.g., from Wastewater Treatment Plant to Water Treatment Plant) due to uncertainties of constituents that may be in reclaimed water and public perception.

   B. Yes, for indirect use to augment a potable supply (e.g., discharge into a reservoir or stream with a downstream diversion) with multiple barriers provided (e.g., advanced wastewater treatment, blending with natural water, detention time).

7. Are permits or approvals required for use of reclaimed water?

   A. For direct use approval of a Chapter 210 Notification (e.g., describes the use of the water, quantity of water, provisions for compliance with rules) has to be obtained from TCEQ.

   B. For indirect use (e.g., discharge to state waterway) a water rights permit is required.

APPENDIX E

DRAFT TRANSMITTAL LETTER
QUESTIONNAIRE
LIST OF BUSINESSES

This appendix contains a draft letter, questionnaire, and list of businesses. The letter will be used to transmit the questionnaire to the businesses listed in order to assess interest in and potential markets for recycled water.

DRAFT TRANSMITTAL LETTER

Date
Customer Name
Address
Dallas, Texas

Subject: Nonpotable Water Uses

The City of Dallas is assessing potential uses for recycle water in the Dallas area by evaluating existing nonpotable water uses of major Dallas water customers. The City has contracted with our firm to initiate the Recycled Water Implementation Plan, a project that is in the preliminary planning stages. No specific projects have been identified; therefore, the City is not offering recycled water at this time.

The State of Texas through the Texas Commission of Environmental Quality (TCEQ) has established a standard for recycled water in 30 TAC Chapter 210, "Use of Reclaimed Water." The TCEQ identifies two types of recycled water uses: Type 1 includes uses where the public may come in contact with the water and Type 2 where the public would not come in contact with the water. The following quality standards for recycled water are identified in Section 210.33 and would be met by Dallas Water Utilities:

TCEQ Standards for Recycled Water

	Type 1	Type 2
BOD [mg/l]	5	20
CBOD [mg/l]	5	15
Turbidity [NTU]	3	---
Fecal Coliform [CFU/100 ml] (*)	20	200
Max. Fecal Coliform [CFU/100 ml] (**)	75	800

(*) Geometric Mean
(**) Single Grab Sample

As a major water customer, you have been contacted to determine your water requirements for industrial, cooling, process, irrigation or other nonpotable purposes. The attached questionnaire is provided to understand your existing water quantity and quality needs and to assess the potential for recycled water to meet those needs in the future. Your responding to this questionnaire will not alter your existing water service in any way.

Please take a few moments to complete the enclosed questionnaire and return it in the enclosed self-addressed stamped envelope. Your assistance is greatly appreciated.

Regards,

DRAFT QUESTIONNAIRE

Nonpotable Water Questionnaire:

Company Name: ____

Address of Water Service: ____

Primary Product or Service: ____

Primary Use of Nonpotable Water:

Usage Type	Quantity Requirements
☐ Landscape irrigation	
☐ Manufacturing (please explain)	
☐ Food Production (crop irrigation)	
☐ Process (please explain)	
☐ Cooling	
☐ Industrial (please explain)	
☐ Other (please specify)	

Nonpotable Water Quality Requirements (if applicable):

Parameter	Quality Requirements
☐ BOD [mg/l]	
☐ CBOD [mg/l]	
☐ Turbidity [NTU]n	
☐ Fecal coliform [CFU/100ml]	
☐ Max. Fecal coliform [CFU/100 ml]	
☐ Other (please specify)	

DRAFT QUESTIONNAIRE MAILING LIST

The list of entities, businesses, and facilities on the following page is the recommended mailing list for this questionnaire:

302 Trails
Alliance FH
Amerisouth
AMLI Residential
AOF/DFW Affordable Housing
Apple Residential Income
Apartment Opportunity Fund
Aspentree Cons Cap Equitable
Attila Construction
Aviall of Texas
Bayport Foxmoor
Brock Apartments
Camden Property
Candlewyck
CEI Group
Crow-Equitable-Nissei
Cushman & Wakefield
Dallas Area Rapid Transit
Dallas Athletic Club
Dallas Baptist University
Dallas Chaucer I
Dallas County MUD NO. 6
Dallas Housing Authority
Dallas Market Center
Devonshire Real Estate
DFW Airport Board
Eastern Hills C Club
Equity Residential Property
Extex Laporte
Fannie Mae
First National Bank
Forest Sun Chancellor
Frankel Edward B Family Trust
GAF Corporation
Gerald Hines
Giddens Harvey
Harry J Fath
Harshaw Asset
Honeycreek Kiwi
John F Firestone
LA/DAV Apartments
Lincoln Properties
Macerich Valley View
Mountain Valley 2002
National Linen Service
Noel Property Management
Nussbaum Family
Occidental Chemical
Park Central Development
Performance Properties
Presbyterian Village
Preston Park Association
Preston Tower Condominiums
Price Preston Park
Ridge Crest
Rock-Tenn
Steve Loftus
Southwest Airlines
Southwestern Bell
Stevens Creek Association
Terrace Partners
Thanksgiving Tower Association
Thurman Apartments of Dallas
Tracy Ishino
Trammel Crow
Trivest Ridgetree
Trizec Properties
TVO Arbors
W J Group
WAK Management
Waterview Development
Wentwood Harverst Hill
Wildflower
Y & O Terrace

APPENDIX F

STANDARD RECYCLED WATER USE AGREEMENT

STATE OF TEXAS §

COUNTY OF DALLAS §

This Agreement, effective as of ____ day of _______, 200__, is made by and between the City of Dallas, Texas, a home rule City operating under the Constitution and the laws of the State of Texas (“City”), and __________ (“Purchaser”).

WITNESSETH:

WHEREAS, the City owns and operates a water distribution system, and a wastewater collection and treatment system, which produces Recycled Water; and

WHEREAS, the City has Recycled Water available for beneficial use to customers who require such water resources; and

WHEREAS, Purchaser desires to purchase from the City certain Recycled Water produced by the City, upon the terms and conditions set forth herein.

NOW THEREFORE, inconsideration of the mutual covenants and agreements contained herein, the City agrees to sell Recycled Water to Purchaser, and Purchaser agrees to pay the City for such delivery of Recycled Water, in the amounts and upon the terms and conditions hereinafter set forth:

SECTION 1. DEFINITION OF TERMS

The following terms and expressions are used in this Agreement shall have the following meanings:

1.1 “EXISTING FACILITIES” means the pumps, pipelines and improvements at the City’s wastewater treatment plant required specifically to provide raw water service to the Purchaser.

1.2 “FISCAL YEAR” means the City’s Fiscal Year, which begins October 1st and ends September 30th of the succeeding year.

1.3 “IRRIGATION SYSTEM” means the means the pumps, pipes and other facilities currently utilized, or the system to be installed by Purchaser on its Property, for irrigation of the Property.

1.4 “POINT OF DELIVERY” means the location at which title to the City’s Recycled Water purchased under this Agreement passes from the City to the Purchaser, as shown on the facilities drawing attached hereto as Attachment A.

1.5 "PROPERTY" means the real property of Purchaser as described in Attachment B upon which the Recycled Water shall be applied by Purchaser for irrigation purposes.

1.6 "PURCHASER" means the buyer of recycled water.

1.7 "RAW WATER" means the water to be delivered and sold to Purchaser, for whatever legal purpose.

1.8 "RECYCLED WATER" means the treated wastewater effluent produced from the City's wastewater treatment plant.

1.9 "RECYCLED WATER DISTRIBUTION FACILITIES" means the pumps, pipes and other Facilities necessary for Purchaser to take Recycled Water from the City's Recycled Water Transportation Facilities for subsequent irrigation use.

1.10 "STORAGE POND" means any pond to be utilized by Purchaser for the storage of Recycled Water delivered to Purchaser and as depicted on the facilities drawing attached hereto as Attachment A.

1.11 "TCEQ" means the Texas Commission on Environmental Quality, or its successor agency.

1.12 "TREATED WASTEWATER EFFLUENT RATE" means the rate to be charged the Purchaser by the City per 1,000 gallons of Recycled Water and is based on the City's reasonable, actual, and expected costs of Providing Recycled Water to Purchaser, including the City's cost in developing or securing future water supplies.

1.13 "WASTEWATER TREATMENT PLANT" means the City's Central or Southside wastewater treatment plants and/or any other wastewater treatment plant owned and operated by the City.

SECTION 2. FACILITIES CONSTRUCTION

2.1 Facilities to be Constructed. As needed or desired, Purchaser shall construct or cause to be constructed the Recycled Water Distribution Facilities and any Storage Pond(s) (collectively, the "Facilities") necessary to distribute and/or store Recycled Water from the City's Point of Delivery. The construction of such facilities shall meet all applicable rules and regulation of the TCEQ for recycled water systems. Prior to Purchaser's use of any Storage Point, whether new or existing, Purchaser shall ensure that such Storage Pond complies with the requirements of Title 30, Texas Administrative Code, Section 210.23.

2.2 Approval of Plans and Specifications. To the extent that new Facilities are proposed by Purchaser, Purchaser shall develop plans and specifications for such facilities and submit such plans and specifications to the City for review and approval prior to construction of the same.

2.3 Inspection. Purchaser's engineer shall inspect new Facilities being constructed, and the City shall provide periodic inspection during construction.

SECTION 3. DELIVERY OF RECYCLED WATER

3.1 Delivery. The City shall operate and maintain the Effluent Transportation Facilities and deliver Recycled Water from the Wastewater Treatment Plant through the Effluent Transportation Facilities to the Point of Delivery. It is agreed and understood that the Point of Delivery shall include a meter for the measurement of Recycled Water delivered to Purchaser. It is agreed that all valves and other controls to start, stop and regulate the flow of water to Purchaser under this Agreement (the "Regulators"), which are beyond the Point of Delivery and its related meter, shall be under the control of the Purchaser. If the quality of the Recycled Water is ever less than that specified in Texas Pollutant Discharge Elimination System Permit No. 11321-001, then the City shall notify Purchaser orally within twenty-four (24) hours of the City becoming aware of such deficiency, and Purchaser shall have the right to suspend acceptance of Recycled Water by notifying the City orally and confirming such suspension in writing within twenty-four (24) hours.

3.2 Authorization. The City, with assistance from the Purchaser, as needed, which assistance will not be unreasonably denied, shall apply to TCEQ for authorization for the Recycled Water project pursuant to TCEQ rules and regulations.

3.3 Use of Water. The Recycled Water delivered by the City shall be used only for Purchaser's storage in any Storage Ponds and for irrigation of the Property described in Attachment B.

3.4 Title. Title to all water supplied hereunder shall be in the City up to the Point of Delivery, at which point title shall pass to Purchaser. The Point of Delivery is specifically delineated and shown on Attachment A and is located at the metering point where Recycled Water delivered to Purchaser is measured.

SECTION 4. QUANTITY AND UNIT MEASUREMENT

4.1 Quantity. The City agrees to sell and deliver Recycled Water to Purchaser at the Point of Delivery. Purchaser agrees to take at the Point of Delivery all Recycled Water desired for use by Purchaser during the term of this Agreement. The Recycled Water will be delivered in accordance with this Agreement. Notwithstanding any other provision of this Agreement to the contrary, in no event shall the City be required to deliver any minimum amount of Recycled Water to Purchaser. Purchaser agrees that the quantity of Recycled Water available for delivery and use by Purchaser shall be solely dependent on the normal operations and production of the Wastewater Treatment Plant.

4.2 Sale by Purchaser. Purchaser may not resell or transfer Recycled Water purchased from the City to any agency, individual, corporation, or other person.

4.3 Measurements.

a. The City shall install, operate, maintain, and read meters that shall record the Recycled Water delivered to Purchaser. The cost for installation of the meter shall be borne by Purchaser. The principal measurement point for water taken by Purchaser under this Agreement shall be located near the designated Point of

Delivery and all meters and other related equipment shall be property of the City.

b. The City shall keep accurate records of all measurement of Recycled Water required under this Agreement and the measuring devices and such records shall be open to inspection by Purchaser during reasonable business hours. Purchaser shall have access to the metering equipment at all reasonable times, but the reading, calibration, and adjustment thereof shall be performed only by employees or agents of the City. Purchaser's agents or employees may observe the reading, calibration, and adjustment.

c. Should Purchaser have reason to believe that a meter is recording water usage inaccurately, Purchaser may request in writing that the City investigate the meter operations. If it is mutually agreed by the City and Purchaser that the meter is malfunctioning, or should the City discover that a meter is recording water usage inaccurately, the City shall immediately notify Purchaser of same, and replace or repair the faulty meter.

d. If, for any reason, a meter is out of service or out for repair so that the Amount of water delivered cannot be ascertained or computed from the reading thereof, the water delivered, through the period such meter is out of service or out for repair shall be estimated and agreed upon by the parties upon the basis of the best data available. For such purpose, the best data available shall be determined by consideration of any other meters in the transmission line which can be related to the main delivery meter. If no other means in the system are operational that will allow determination of delivered quantity, then the amount of water delivered during such period may be estimated by (i) correcting the error if the percentage of error is ascertainable by calibration tests or mathematical calculation, or (ii) estimating the quantity of delivery by deliveries during preceding periods under similar conditions when the meter was registering accurately.

4.4 Units of Measurement. The unit of measurement for Recycled Water delivered hereunder shall be 1,000 gallons of water, U.S. Standard Liquid Measure.

SECTION 5. QUALITY

5.1 General. The Recycled Water to be delivered by the City shall be treated wastewater effluent in compliance with applicable State and Federal Law. This water is not intended for human consumption or domestic purposes and is to be used only for irrigation purposes in watering a landscape or a ball field, a golf course and for Storage Pond evaporation makeup and for no other purposes. Purchaser has satisfied itself that such water will be suitable for its use; provided that if at any time the quality of water delivered is dangerous to human health when applied by Purchaser's irrigation system or otherwise less than that required to maintain vigorous, healthy plant growth for the plant material at the Purchaser's facilities, then Purchaser may immediately terminate or suspend this Agreement and may refuse acceptance of the water, and Purchaser will not be liable for any payments for any period of non-acceptance. THERE ARE NO WARRANTIES, EXPRESS OR IMPLIED, WHICH EXTEND BEYOND

THE DESCRIPTION CONTAINED IN THIS AGREEMENT RELATIVE TO THE QUALITY OF THE RECYCLED WATER.

5.2 Quality Testing. The quality of Recycled Water will be tested once per week by City staff. The sampling point will be at the Wastewater Treatment Plant (WWTP) producing such water. The tests will be conducted to verify that the water quality is in accord with the intended uses identified in this Agreement. Results of the tests will be reported to TCEQ on a monthly basis and kept at the WWTP office for a period of at least five years.

SECTION 6. PAYMENTS BY PURCHASER FOR RECYCLED WATER RECEIVED

6.1 Commencement of Service. The City shall begin to provide Recycled Water to Purchaser within 30 days after completion of the Facilities and the WWTP. When Purchaser begins receiving Recycled Water, the provisions of this Agreement will be in full force and effect.

6.2 Rate. The City shall charge Purchaser and Purchaser shall pay City for the Recycled Water delivered to the Purchaser at the Treated Wastewater Effluent Rate as defined in Section 2.2. The initial rate for Recycled Water purchased under this Agreement shall be $_______ per 1,000 gallons. The City may adjust the rate per 1,000 gallons annually, based on increases in the City's operating and maintenance costs, and/or on the market value of the Recycled Water, including the costs of the City in developing or securing future water supplies.

6.3 Billing. The City shall bill Purchaser for Recycled Water sold under this Agreement as follows:

a. Billing will be on a monthly basis.

b. The City will submit to Purchaser a monthly statement for Recycled Water. The monthly statement will be payable on or before thirty (30) days after receipt of the invoice.

c. The City will retain the right to suspend water service if the Purchaser has not paid its monthly statement by the 10th day after receiving notice that the invoice is delinquent.

SECTION 7. SUSPENSION OF SERVICE

7.1 Force Majeure. If, at any time during the term of the Agreement, the City is unable to deliver Recycled Water under the terms of this Agreement due to circumstances beyond the City's control and without its fault, whether such occurrence or circumstance be an act of God or the common enemy or the result of war, riot, civil commotion, sovereign conduct, or the act or conduct of any person or persons not party or privy hereto, then the City shall be excused from such performance for such period of time as is reasonably necessary after such occurrence to remedy the effects thereof, and the City shall not be liable for the breach of this Agreement. The City shall use reasonable and good faith efforts to correct any impediment preventing delivery of Recycled Water and give Purchaser advance notice when possible and to the extent it is reasonable, give such notice of any inability to deliver the water needed so that Purchaser may seek alternative sources.

7.2 Repairs and Maintenance. The City may temporarily suspend delivery of Recycled Water to Purchaser for the purpose of performing maintenance and repairs to the Effluent Transportation Facilities or other parts or components of the City wastewater system including its Wastewater Treatment Plant. The City shall endeavor to provide Purchaser with verbal notice prior to suspension of such service and an estimate of when service shall be re-established.

7.3 Regulatory Action. The City may temporarily suspend delivery of Recycled Water to Purchaser pursuant to the request, written order, or direction of any regulatory agency having jurisdiction over the use of Recycled Water. The City shall endeavor to provide Purchaser with verbal notice prior to suspension of such service and an estimate of when service shall be re-established.

SECTION 8. OBLIGATIONS OF THE PARTIES

8.1 Obligations of the City.

a. Operation and Maintenance. The City will continuously operate and maintain the Recycled Water Transportation Facilities (including the expansion thereof). The schedule for maintenance of these facilities will be incorporated into the City's routine maintenance program schedule.

b. Training. The City agrees to adequately train its operations personnel in the safe use of Recycled Water as well as the legal requirements for record keeping and reporting. The City will conduct a training and safety meeting for all of its maintenance personnel following TCEQ approval of its Reclaimed Water Use Notification. All new wastewater utility workers will be provided this information during new employee orientation.

c. Conditions of Service. It is expressly understood and agreed that any obligations on the part of the City to provide Recycled Water to Purchaser be (a) conditioned upon the City's ability to maintain all necessary permits, agreements, material, labor, and equipment, provided the City uses reasonable efforts to maintain said permits, agreements, material, labor and equipment; (b) subject to all present and future valid laws, order, rules, and regulations of the United States of America, the State of Texas, and any government or regulatory body having jurisdiction over the City or its activities; and, (c) subject to the right of the City to terminate Recycled Water deliveries under this Agreement when the City finds the Purchaser's use of such water to be noncompliant with the provisions of the TCEQ Recycled Water use rules, located at Title 30 of the Texas Administrative Code, Section 210.

8.2 Obligations of the Purchaser.

a. System Operation and Maintenance. Purchaser shall be responsible to operate and maintain its Recycled Water Distribution Facilities necessary for the distribution of the Recycled Water from the Point of Delivery to the place of use, including the use of any Storage Pond and Irrigation System, at its sole risk and expense, including the obtaining of any necessary permits or easements therefore. Nothing in this Agreement shall be construed to authorize Purchaser to install any equipment or improvements on property owned by the City without the express written consent of the City and subject to such conditions as the City may impose. Nothing in this Agreement, however, shall in any way limit the rights of Purchaser under any other agreement with the City including the right to tie onto meters at the designated Point of Delivery at the Project Facilities.

b. Construction Requirements. Purchaser agrees that it will be responsible for the design of any Recycled Water Distribution Facilities and/or Irrigation System in accordance with the provisions of 30 Texas Administrative Code, Section 210.25. Construction plans for any new Recycled Water Distribution Facilities and/or Irrigation System shall be submitted to the City for review and approval prior to construction in accordance with the provision of 30 Texas Administrative Code, Section 210.25.

Purchaser agrees that it will ensure that any Recycled Water Distribution Facilities shall be constructed with a minimum separation from potable water lines of nine (9) feet whenever possible. When it is not possible to maintain this separation, Purchaser agrees to construct such facilities in accordance with 30 Texas Administrative Code, Chapter 290, concerning separation of potable and nonpotable water piping. Purchaser agrees to use a nondegradable warning tape in the trench of such facilities to reduce the possibility of inadvertent cross-connections. Pipe used for construction of any additional Recycled Water lines shall be purple, covered with purple polywrap bag, or marked with purple tape.

c. Storage Ponds. Purchaser agrees that it will be responsible for the design or modification, as necessary, of any Storage Ponds. Such ponds shall be designed or modified to meet the requirements of 30 Texas Administrative Code, Section 210.23. Construction plans for any new Storage Pond shall be submitted to the City for review and approval prior to construction in accordance with the provisions of 30 Texas Administrative Code, Section 210.23.

d. Hose Bits, Faucets, Valves. Purchaser agrees that it will be responsible for designing all hose bibs, faucets, and valves in accordance with the provisions of 30 Texas Administrative Code, Section 210.25.

e. Signage. Purchaser agrees that it will be responsible for posting signs at all Storage Ponds, hose bibs, faucets and other points of access to the Recycled Water that comply with the requirements of 30 Texas Administrative Code, Section 210.25.

f. Irrigation System Operation. Purchaser agrees that it will ensure that the Irrigation System is operated in a manner that will minimize the risk of inadvertent human exposure. Purchaser agrees that it will operate the Irrigation System in a manner that will not cause any surface or airborne discharge of Recycled Water to any privately-owned premises outside the designated irrigation area or reach public drinking fountains. The Irrigation System shall not be operated when the ground is frozen or saturated with water. The Purchaser agrees that it will ensure that areas to be irrigated have a vegetative cover when irrigation occurs and take measures to assure no incidental ponding of water. Purchaser agrees to implement operational procedures so that use of the Irrigation System will minimize wet grass conditions in "unrestricted landscaped areas" during the periods such areas could be in use. "Unrestricted landscaped areas" is defined in 30 Texas Administrative Code, Section 210.3. Purchaser agrees that such procedures will also ensure that no water spray or spray drift reaches off-premises property outside the ownership or control of Purchaser.

g. Training. Purchaser agrees to train and inform the groundkeepers and maintenance personnel of the proper usage of the recycled water, the potential health risks, and proper safety precautions. All new workers are to be informed of this information during new employee orientation.

h. Syringing Greens. City and Purchaser agree that Purchaser may want to irrigate ball fields or golf course greens during the day to alleviate heat stress experienced by grass. This process is called "syringing the greens." Purchaser agrees that such syringing will be allowed only while the greens are unoccupied and will be accomplished with hand-held hoses.

i. Routine Maintenance. Purchaser agrees to schedule routine maintenance on its Recycled Water Distribution Facilities, any Storage Ponds, and the Irrigation System. Purchaser's routine maintenance schedules shall include a routine check of the sprinkler heads, distribution piping, pumps, valves, and other mechanical equipment. Repairs shall be conducted as necessary. Preventive maintenance on all mechanical equipment shall be as specified by the manufacturer.

j. Discharges Prohibited. Purchaser shall not allow Recycled Water contained in any Storage Pond to be discharged into "waters in the State," as that term is defined in Water Code, Section 26.001, except for discharges directly resulting from rainfall events. In the event of a discharge, Purchaser shall comply with the requirements of 30 Texas Administrative Code, Section 210.22.

k. Inspection. Purchaser hereby grants the City the right to inspect Purchaser's Recycled Water Distribution Facilities and the Irrigation System, as well as the areas where Recycled Water is stored or use for irrigation.

l. Acknowledgment by Purchaser. By its execution of this Agreement, Purchaser acknowledges its receipt of a copy of the TCEQ Recycled Water use rules also located in Title 30 of the Texas Administrative Code, Chapter 210 and further agrees to comply with all requirements and responsibilities under such rules.

SECTION 9. GENERAL PROVISIONS

9.1 Indemnification. THE CITY, ITS OFFICERS, AGENTS, AND EMPLOYEES SHALL NOT BE HELD LIABLE OR RESPONSIBLE FOR, AND SHALL BE SAVED AND HELD HARMLESS BY PURCHASER FROM AND AGAINST ANY AND ALL CLAIMS, SUITS, ACTIONS, ENFORCEMENT ACTIONS, LOSSES, DAMAGES, OR LIABILITY, INCLUDING ALL LITIGATION, COSTS, AND ATTORNEYS' FEES BROUGHT BY ANY PERSON, ENTITY OR REGULATORY AUTHORITY ARISING OUT OF, OR OCCASIONED BY THE ACTS OF PURCHASER OR PURCHASER'S AGENTS OR EMPLOYEES IN THE EXECUTION OR PERFORMANCE OF THIS CONTRACT, PURCHASER'S USE OF RECYCLED WATER, AND PURCHASER'S OPERATION OF THE FACILITIES.

9.2 Venue. All amounts due under this Agreement, including, but not limited to, payments due under this Agreement or damages for the breach of this Agreement, shall be paid and be due in Denton County, Texas, which is the County in which the administrative offices of the City are located. It is specifically agreed by the parties to this Agreement that Denton County, Texas, is the place of performance of this Agreement; and in the event that any legal proceeding is brought to enforce this Agreement or any provision hereof, the same shall be brought in Denton County, Texas.

9.3 Severability. The provisions of this Agreement are severable, and if any provision or part of the Agreement or the application thereof to any person or circumstance shall ever be held by any court of competent jurisdiction to be invalid or unconstitutional for any reason, the remainder of this Agreement and the application of such provision or part of the Agreement to other persons or circumstances shall not be affected thereby.

9.4 Titles. Titles and subtitles Articles contained herein are for convenience only and have no legal or other effect on the terms of this Agreement.

9.5 Prior Agreement Superseded. This Agreement constitutes the sole and only Agreement of the parties with respect to the delivery of Recycled Water to Purchaser and cancels and supersedes any prior understandings or oral or written agreements between the parties respecting the delivery of any water supply to Purchaser.

9.6 Signatory Authority. The persons signing this Agreement acknowledge by their signatures that they have all proper and lawful authority to act on behalf of the entities they purport to represent and to bind such entities in accordance with the rights and obligations contained in this Agreement.

9.7 Address and Notice. Unless otherwise provided in the Agreement, any notice, communication, request, reply, or advice (herein severally and collectively, for convenience called "Notice") herein provided or permitted to be given, mode or accepted by any party must be in writing and may be given or served in any manner reasonably calculated to reach of the other parties. Notice sent by certified or registered mail, postage prepaid, return receipt requested, shall be deemed to have been received on the second mail delivery day following the day on which it was posted. Notice by any other method shall be effective when received. For the purpose of Notice, the addresses of the Parties shall be, until changed as hereafter provided, as follows:

Purchaser: (Name)
(Street Address)
(City, State, Zip)
(Phone Number)
(Facsimile Number)

City: City of Dallas
Attn: Director of Water Utilities
2121 Main Street, Suite 300
Dallas, Texas 75201

Any party may change the address for notice by giving notice of such change in accordance with the provisions of this section.

9.8 State and Federal Laws, Rules, Order or Regulations. This Agreement is subject to all applicable Federal and State Laws and applicable permits, ordinances, rules, order, and regulations of any local, State, or Federal Governmental Authority having or asserting jurisdiction, but nothing contained herein shall be construed as a waiver of any right to questions or contest any such law, ordinance, order, rule or regulation in any forum having jurisdiction.

9.9 Applicable Law. The validity of this Agreement and of any of its terms or provisions, as well as the rights and duties hereunder, shall be governed by the laws of the State of Texas.

SECTION 10. ASSIGNMENT

10.1 Term of Agreement. This Agreement shall be in force and effect from the date of execution hereon for a term of ten (10) years.

10.2 Option of Renewal. The parties hereby agree that Purchaser shall have an option to renew and extend this Agreement, which option shall be exercised in advance of the expiration date of this Agreement by Purchaser giving the City written notice one hundred eighty (180) days prior to the expiration date or within thirty (30) days of receipt of written notice from the City notifying Purchaser of its option rights, whichever comes later. The terms of the renewal and extension shall be for one additional 10-year term from said date of expiration of this Agreement and shall be on the same terms as this Agreement, except as to the extent that regulatory requirements associated with the City's delivery of Recycled Water, or the lawful right of the City to deliver Recycled Water to Purchaser, may affect such service.

10.3 Assignment. This Agreement shall not be assignable by Purchaser in whole or in part without the written consent of the City except that such consent shall not be unreasonably withheld. The City and Purchaser agree that each binds themselves and their successors and assigns to all obligations, promises and covenants of this Agreement.

10.4 Transfer. In the event the City wishes to assign, convey or otherwise relinquishes its obligations with respect to the provision of Recycled Water service to Purchaser under this Agreement, in its sole discretion, such that the City is no longer operating the Wastewater Treatment Plant and/or its Recycled Water Transportation System, City's obligations under this Agreement shall be the responsibility of City's assignee.

Section 11. REMEDIES UPON DEFAULT

11.1 Default. Notwithstanding anything herein to the contrary, no party shall be deemed to be in default hereunder until the passage of thirty (30) calendar days after receipt by such party of notice of default from the other party. Upon the passage of thirty (30) calendar days without cure of the default, such party shall be deemed to have defaulted for the purposes of this Agreement.

11.2 No Additional Waiver Implied. The failure of any party hereto to insist in any one or more instances upon performance of any of the terms, covenants, or conditions of this Agreement shall not be construed as waiver or relinquishment of the future performance of any term, covenant, or condition by the other parties hereto, but the obligation of such other parties with respect to such future performance shall continue in full force and effect.

11.3 Remedies. The Parties recognize that certain of their respective obligations, if not performed, may be adequately compensated by money damages while other could not be. Accordingly, the Parties agree that in the event of any failure to perform any covenants, conditions, or obligations of this Agreement on the part of any party, the aggrieved party shall:

a. to the extent, if any, permitted by law, have the remedy of specific performance of this Agreement, in addition to any other remedies otherwise available at low or in equity or under this Agreement; and

b. either City or Purchaser may terminate this Agreement by written notice, after such party has given notice of a material default to the other party upon the expiration of the thirty (30) days permitted for curing such default and such default not having been cured.

IN WITNESS WHEREOF, the Parties hereto acting under the proper authority have caused this Agreement to the duly executed in several counterparts, each of which shall constitute an original, on this ________ day of __________, 200__, all as of the day and year first written, which is the effective date of this Agreement.

PURCHASER

By: ______________________________

Title: ______________________________

THE CITY OF DALLAS

By: ______________________________

Robert M. Johnson, P.E.
Director of Water Utilities

ATTEST:

____
City Secretary

Approved:

____
City Attorney

APPENDIX G

PROJECT DEFERRAL BENEFITS ANALYSIS

Planned Raw Water Supply Projects Deferral

One of the most significant financial benefits of implementing recycled water projects is that, if a significant quantity of recycled water is used, future planned raw water supply projects can be deferred. The recycled water projects would supply the initial volume to be provided by a planned supply project. The recycled water projects would be considered alternative raw water supply projects, providing a significant volume of raw water at lower costs than projected new reservoir projects. Using recycled water as an alternative supply does not necessarily eliminate the need to develop other sources, but it does free financial resources for use on other projects during the delay.

From the "Draft 2005 Update of Long Range Water Supply Plan," (2005 Draft LRWSP) the Lake Palestine Supply Project includes two potential alternatives:

1. 84-inch Pipeline and Pump Station from Lake Palestine to new SE WTP at a capital cost of about $541 MM.
2. 84-inch Pipeline and Pump Station from Lake Palestine to existing East Side WTP at a capital cost of about $554 MM.

The recommended DWU recycled water projects are estimated to provide 18.25 MGD of average day demand and 33.5 MGD peak day demand. Based on the 2005 Draft LRWSP, it is anticipated that the Lake Palestine raw water supply will be connected by 2015. The 2005 Draft LRWSP also assumes direct recycled water projects totaling 18.25 MGD will be implemented by 2012. Without these recycled water projects, the Lake Palestine supply would have to be connected approximately 3 years sooner than is currently planned. Deferring the Lake Palestine project will allow DWU to delay the associated financing, taxes and/or rate increases associated with the project, providing a real and tangible benefit to DWU's potable water customers.

The recycled water program will also defer the need to increase capacity at DWU water treatment facilities.

It should also be recognized that the implementation of the proposed recycled water program would result in the loss of retail revenues. The loss of retail revenues results from customers that historically have relied upon potable water to meet their water needs converting to recycled water to meet those needs.

The financial and economic benefit associated with deferral of the Lake Palestine raw water supply connection and deferral of a water treatment capacity increase, is estimated to be approximately $61.8 million. This estimate accounts for anticipated loss of revenue from customers who convert to recycled water. The following sections describe the methodology used to determine the financial and economic benefits and costs.

Economic Analysis of Deferring the Lake Palestine Water Supply Project

The recommended DWU recycled water program is estimated to meet 18.25 MGD in average day demand. DWU has a forecasted water demand of 529 MGD for 2010, increasing to 606 MGD for 2020, or a 1.37 percent effective annual growth rate over the 10-year period. Based on the 2005 Draft LRWSP (which includes implementation of the direct recycled water program by 2012), it is anticipated that the Lake Palestine raw water supply will be connected in 2015. Without the direct recycled water program, Lake Palestine would need to be connected by approximately 2012.

Initial estimates of the lowest cost alternative place the cost of the Lake Palestine raw water supply connection at $541 million (2004 dollars). With an annual cost inflation of 2.5 percent, the cost of the Lake Palestine raw water supply connection would increase to $709.8 million in 2015. If the project were constructed in 2012, the cost would be $659.2 million. Assuming a 30-year bond issued at 5 percent annual interest, the annual principal and interest would be $46.2 million for 2015 construction and $42.9 million for 2012 construction. The total increase in principal and interest payments resulting from deferral of the Lake Palestine project to 2015 is $98.9 million.

Although there is an increase in cost by deferring the Lake Palestine construction by three years, in present value dollars, there is actually a $62.8 million benefit to deferring the project. This benefit is a result of the time value of money. DWU will be able to defer three years of principal and interest payments estimated at $128.6 million. In addition, it is assumed that the annual cost deferred will be able to earn a return of 3 percent annually, so that at the end of the three-year period, the deferral would be valued at $134.5 million. The annual principal and interest payment differential between the 2012 bond and the 2015 bond is $3.3 million. Because of the substantial value of the three-year deferral, the return on the deferred cost is more than sufficient to offset the difference in principal and interest payments. Over the life of the bond issue, a benefit of $62.4 million results from deferral. In addition, $32.8 million of deferral benefits (present value of $6.7 million) will be available after final payment of the 2015 bond issue. It should be noted that the $32.8 million would be available to earn a return; however, as a conservative measure, a value of this return was not included in the analysis.

Present Value of Benefit of Deferring Debt Issue	$ 62.4 million
Present Value of Benefit of Remaining Cost Deferral	$ 6.7 million
Total Present Value of Deferring Lake Palestine Connection	$ 69.1 million

Economic Benefit of Deferring the Water Treatment Plant Expansion

The recommended DWU recycled water program is estimated to meet 33.5 MGD in peak day demand. Based on the forecasted water demands for DWU, it is estimated that additional water treatment capacity increases will be deferred by three years with the implementation of the recycled water program. Water treatment construction costs were assumed at $1.00 per gallon of added capacity; therefore construction costs for 33.5 MGD of additional capacity would be $33.5 million. With an annual cost inflation of 2.5 percent, the cost of the water treatment construction would increase to $36.1 million with the three-year deferral. Assuming a 30-year bond issued at 5 percent annual interest the annual principal and interest would be $2.18 million assuming no deferral and $2.35 million with the three-year deferral. The increase in principal and interest payments by deferring water treatment capacity construction is $5.0 million.

Although there is an increase in cost by deferring water treatment construction by three years, in present value dollars, there is actually a $3.5 million benefit to deferring the construction. This benefit is a result of the time value of money. DWU will be able to defer three years of principal and interest payments estimated at $6.5 million. In addition, it is assumed that the annual cost deferred will be able to earn a return of 3 percent annually, so that at the end of the three-year period, the deferral would be valued at $6.8 million. The annual principal and interest payment differential between not deferring the water treatment construction and deferring the construction is about $168,000. Because of the value of the three-year deferral, the return on the deferred cost is more than sufficient to offset the difference in principal and interest payments. Over the life of the bond issue, a benefit of $3.17 million results from deferral. In addition, $1.67 million of deferral benefits (present value of $340,000) will be available after final payment of the deferred bond issue. It should be noted that the $1.67 million will be available to earn a return; however, as a conservative measure, a value of this return was not included in the analysis.

Present Value of Benefit of Deferring Debt Issue	$3.17 million
Present Value of Benefit of Remaining Cost Deferral	.34 million
Total Present Value of Deferring Water Treatment Construction	$3.51 million

Loss of Retail Water Revenue

With recycled water supplementing water use of customers that historically relied upon potable water to meet their water demand, a loss of treated water revenues will occur. Applying the 18.25 MGD of average day recycled water, it is estimated that it will take three years for growth in treated water demand to replace the reduction in treated water due to the recycled water program. Currently, DWU Optional General Services retail treated water rate is $1.22 per 1,000 gallons for consumption above 1 million gallons. It is assumed that all potential recycled water customers supplied the 18.25 MGD of recycled water are currently charged the Optional General Services rate. With a reduction in treated water production as a result of the recycled water program, a reduction in variable production costs should occur; therefore some of the loss in retail water revenue will be offset by a reduction in production costs. An assumption of 30 percent variable cost was applied to the $1.22 rate, resulting in a net loss per 1,000 gallons of $0.85. With the three-year deferral, the present value of the treated retail water revenue lost due to the recycled water program is estimated to be $10.8 million.

Summary

It is estimated that the total financial and economic present value benefit of the recommended recycled water program is <u>$61.8 million</u> as illustrated in Table G-1.

TABLE G-1
PRESENT VALUE
RAW WATER PROJECT DEFERRAL BENEFIT

Benefits	**(in Millions)**
Deferring Lake Palestine Connection	$69.1
Deferring Water Treatment Construction	$ 3.5
Total Present Value of Benefits	**$72.6**
Costs	
Lost Retail Water Revenues	$10.8
Total Present Value of Benefit/(Cost)	**$61.8**